M.TECH PROGRAMME IN

AUTOMOTIVE ELECTRONICS

SCHEME I TO IV SEMESTER: 2021-2022

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SYLLABUS I TO IV SEMESTER: 2021-2022

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

Scheme of Teaching and Examination for M. Tech (MAL)

(For the Academic year 2021-2022)

Dean Academics
JSS STU, Mysuru

PRINCIPAL
Sri Jayachamarajendra College of Engineering
Constituent College of JSS Science and Technology University
MYSURU-570 006.

Registrar
JSS Science & Technology University
JSS Technical Institutions' Campus
Mysuru 570 006, Karnataka

Vision Statement of the JSS Science and Technology University

1. Advancing JSS S&T University as a leader in education, research and technology on the international arena.
2. To provide the students a universal platform to launch their careers, vesting the industry and research community with skilled and professional workforce.
3. Accomplishing JSS S&T University as an epicenter for innovation, center of excellence for research with state-of-the-art lab facilities.
4. Fostering an erudite, professional forum for researchers and industrialist to coexist and to work cohesively for the growth and development of science and technology for betterment of society.

Mission Statement of the JSS Science and Technology University

1. Education, research and social outreach are the core doctrines of JSS S&T University that are responsible for accomplishment of in-depth knowledge base, professional skill and innovative technologies required to improve the socio economic conditions of the country.

2. Our mission is to develop JSS S&T University as a global destination for cohesive learning of engineering, science and management which are strongly supported with interdisciplinary research and academia.

3. JSS S&T University is committed to provide world class amenities, infrastructural and technical support to the students, staff, researchers and industrial partners to promote and protect innovations and technologies through patents and to enrich entrepreneurial endeavors.

4. JSS S&T University core mission is to create knowledge led economy through appropriate technologies, and to resolve societal problems by educational empowerment and ethics for better living.

Vision statement of the department of E&CE

Be a leader in providing globally acceptable education in electronics and communication engineering with emphasis on fundamentals-to-applications, creative thinking, research and career-building.

Mission statement of the department of E&CE

1. To provide best infrastructure and up-to-date curriculum with a conducive learning environment.
2. To enable students to keep pace with emerging trends in Electronics and Communication Engineering.
3. To establish strong industry participation and encourage student entrepreneurship.
4. To promote socially relevant eco-friendly technologies and inculcate inclusive innovation activities.

Program Outcomes (POs)

1. **Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis**: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences
3. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems**: Using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
5. **Modern Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6. **The Engineer and Society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

11. **Lifelong Learning**: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
12. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Program Specific Outcomes (PSOs)

1. Analyze, design and provide engineering solutions in the areas of electronic circuits and systems.
2. Demonstrate the mathematical modeling techniques, nurture analytical and computational skills to provide engineering solutions in the areas of electronics and communication.
3. Ability to address multidisciplinary research challenges and nurture entrepreneurship.

Program Educational Objectives (PEOs)

1. To enable the graduates to have strong Engineering fundamentals in Electronics & Communication, with adequate orientation to mathematics and basic sciences.
2. To empower graduates to formulate, analyze, design and provide innovative solutions in Electronics & Communication, for real life problems.
3. To ensure that graduates have adequate exposure to research and emerging technologies through industry interaction and to inculcate professional and ethical values.
4. To nurture required skill sets to enable graduates to pursue successful professional career in industry, higher education, competitive exams and entrepreneurship.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

Scheme of Teaching and Examination for M. Tech Program (Automotive Electronics)

SEMESTER	CREDITS
I	28
II	28
III	14
IV	18
TOTAL	88

SCHEME OF STUDY AND SYLLABUS FOR M. Tech in AUTOMOTIVE ELECTRONICS 2021

PG PROGRAM STRUCTURE (COMMON TO ALL PG PROGRAMS)

The following program structure shall be followed for all the PG Programs in the department.

Total Credits		**= 88** credits
Semester 1:		
	2 Mandatory courses (3+2 credits)	= **05** credits
	2 Core subjects (5 credits (5x2))	= **10** credits (4:0:1 or 4:1:0)
	2 Electives (5 credits (5x2))	= **10** credits (4:0:1 or 4:1:0)
	1 Design Lab (1.5) + LAB (1.5)	= **03** credits
Total		**= 28** credits
Semester 2:		
	3 Core subjects (5 credits (5x3))	= **15** credits (4:0:1 or 4:1:0)
	1 Electives (5 credits (5x1))	= **05** credits (4:0:1 or 4:1:0)
	1 Open electives (5 credits (5x1))	= **05** credits
	1 Design Lab (1.5) + LAB (1.5)	= **03** credits
Total		**= 28** credits
Semester 3:		
	Industrial Training 8 weeks	**= 04** credits
	Project Evaluation Phase 1	**= 10** credits
Semester 4:		
	Project work and dissertation	**= 18** credits
Grand Total		**= 88** credits

Academic schedule:

Course work :(16 weeks + 1week preparation+ 2 weeks' exams+ 2 Weeks' vacation) 21 X 2 = **42 weeks**

Training = 0**8 weeks**

PROJECT work and dissertation: **= 40 weeks**

Report preparation, submission, viva voce, result: **= 14 weeks**

TOTAL **= 104 weeks**

CONTINOUS EVALUATION SCHEDULE FOR PROJECT WORK

Event	Credits	Marks	Schedule
III SEM			
Industrial Training	04	100	Within 8th week
Synopsis Evaluation	05	50	Within 6th week
Mid-term Evaluation 1 (Project work Phase I)	05	50	Within 18th week
	Total	**200**	
IV SEM			
Mid-term Evaluation 2	18	200	Within 30th Week
Final internal seminar and demonstration			Within 40th Week
Report preparation			Within 44th Week
Evaluation of Project work External evaluation and Viva voce exam		200	Within 52nd Week
Declaration of results	**Total**	**400**	Within 54th Week

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SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU

Scheme of Teaching and Examination for M. Tech (MAL)

SEMESTER: I

SL No	Code	Course Title	L	T	P	Total credits	Contact hours	CIE	SEE	Total Marks	Exam duration
1	**ECPG M1X**	Mandatory Course 1	3	0	0	3	3	50	50	100	3 hours
2	**ECPG M2X**	Mandatory Course 2	2	0	0	2	2	50		50	-
3	**MAL110**	Hybrid Electric Vehicles	4	1	0	5	6	50	50	100	3 hours
4	**MAL120**	Digital Control Systems	4	1	0	5	6	50	50	100	3 hours
5	**MAL14X**	Professional Elective 1	4	1	0	5	6	50	50	100	3 hours
6	**MAL15X**	Professional Elective 2	4	1	0	5	6	50	50	100	3 hours
7	**MAL 16L**	Digital Control Systems Lab	0	0	1.5	1.5	3	50		50	-
8	**MAL17L**	Design and implementation -1	0	0	1.5	1.5	3	50		50	-
		TOTAL				**28**	**35**	**350**	**250**	**650**	

Mandatory Courses-1

COURSE CODE	COURSE TITLE	CREDIT PATTERN
ECPGM11	Linear Algebra	3:0:0
ECPGM12	Graph Theory	3:0:0
ECPGM13	Data Analytics	3:0:0
ECPGM14	Transform Techniques	3:0:0
ECPGM15	Object Oriented Programming Using JAVA	3:0:0
ECPGM16	Advanced Microcontrollers and Applications	3:0:0
ECPGM17	Mathematical modeling and simulation	3:0:0

Mandatory Course - 2

COURSE CODE	COURSE TITLE	CREDIT PATTERN
ECPGM21	Technical report writing and documentation	2:0:0
ECPGM22	Research Methodology	2:0:0
ECPGM23	Sustainable technologies	2:0:0
ECPGM24	Social implications of technology	2:0:0
ECPGM25	Entrepreneurship and Project Management	2:0:0
ECPGM26	Electronic waste management	2:0:0
ECPGM27	Internet and Society	2:0:0

PROGRAM CORE COURSES: (Two courses from among 1 to 4 will be offered)

Sl No	Code	Course Title	Credit Pattern
1	**MAL110**	Hybrid Electric Vehicles	4:1:0
2	**MAL120**	Digital Control Systems	4:1:0
3	**MAL130**	Automotive Software Engineering	4:1:0
4	**MAL140**	Automotive Materials	4:1:0
5	**MAL16L**	Digital Control Systems lab	0:0:1.5
6	**MAL17L**	Design and Implementation - I	0:0:1.5

PROGRAM ELECTIVES (Two electives to be chosen)

	Sl No	Code	Course Title	Credit Pattern
Professional Elective 1	**1**	**MAL141**	Robotics and Automation	4:1:0
	2	**MAL142**	Automotive Transmission	4:1:0
	3	**MAL143**	Advanced Embedded Systems	4:1:0
Professional Elective 2	**1**	**MAL151**	Chassis and Body Electronics	4:1:0
	2	**MAL152**	Vehicle Body Engineering and Safety	4:1:0

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Scheme of Teaching and Examination for M. Tech (MAL)

SEMESTER: II

SL No	Code	Course Title	L	T	P	Total credits	Contact hours	CIE	SEE	Total Marks	Exam duration
1	**MAL210**	Autotronics	4	1	0	5	6	50	50	100	3 hours
2	**MAL220**	Vehicle Engineering	4	1	0	5	6	50	50	100	3 hours
3	**MAL230**	Automotive Instrumentation	4	1	0	5	6	50	50	100	3 hours
4	**MAL24X**	Professional Elective 3	4	1	0	5	6	50	50	100	3 hours
5	**ECPGOLX**	Open Elective	4	1	0	5	6	50	50	100	3 hours
6	**MAL26L**	Computer Aided Design Lab	0	0	1.5	1.5	3	50		50	
7	**MAL27L**	Design and implementation -2	0	0	1.5	1.5	3	50		50	
		TOTAL				**28**	**36**	**350**	**250**	**600**	

PROGRAM CORE COURSES: SECOND SEMESTER (Three courses among 1 to 5 will be offered)		
Code	**Course Title**	**Credit Pattern**
MAL210	Autotronics	4:1:0
MAL220	Vehicle Engineering	4:1:0
MAL230	Automotive Instrumentation	4:1:0
MAL240	PLCs and Industrial Automation	4:0:1
MAL250	Design of Mechanical Systems	4:1:0

PROFESSION ELECTIVE 3: SECOND SEMESTER (One Elective to be chosen)		
Code	**Course Title**	**Credit Pattern**
MAL241	Automotive Networking	4:1:0
MAL242	Emission and Control	4:1:0
MAL243	Automotive Electrical and Electronic system	4:1:0

LIST OF OPEN ELECTIVE COURSES:

Students from any specialization have to register for ONE course in the even semester among these courses depending on which course is offered by the department

Course Code	**Course Title**	**Credit pattern**
ECPGOL1	IOT – Internet of Things	4:1:0
ECPGOL2	Solar Energy Systems	4:1:0
ECPGOL3	Machine learning	4:1:0
ECPGOL4	Six Sigma and manufacturing	4:1:0
ECPGOL5	Heuristics for optimization	4:1:0
ECPGOL6	Organizational Behavior and Financial Management	4:1:0
ECPGOL7	Deep learning	4:1:0
ECPGOL8	MEMS	4:1:0
ECPGOL9	Artificial Neural Networks	4:1:0

Note:

Students from M. Tech (LNI & MAL) specialization can to register for ONE course in the even semester among these courses depending on which course is offered by the department.

Course Code	Course Title	Credit pattern
ECPGOL4	Six Sigma and manufacturing	4:1:0
ECPGOL2	Solar Energy Systems	4:1:0
ECPGOL3	Machine learning	4:1:0

Students from M. Tech (LIE & MAL) specialization can to register for ONE course in the even semester among these courses depending on which course is offered by the department.

Course Code	Course Title	Credit pattern
ECPGOL7	Deep learning	4:1:0
ECPGOL8	MEMS	4:1:0
ECPGOL9	Artificial Neural Networks	4:1:0

Students from M. Tech (LNI & LIE) can to register for ONE course in the even semester among these courses depending on which course is offered by the department.

Course Code	Course Title	Credit pattern
ECPGOL1	IOT	4:1:0
ECPGOL5	Heuristics for optimization	4:1:0
ECPGOL6	Organizational Behavior and Financial Management	4:1:0

SEMESTER III

SI No	Subject Code	Course Title	No of Credits				Marks Allocated			Exam duration
			L	T	P	Total	CIE	SEE	Total	
1	MAL31T	Practical Training in Industrial / Exploration Research	-	-	-	4	100	-	100	
2	MAL32P	Project Phase - I	-	-	-	10	100	-	100	
		TOTAL	-	-	-	**14**	**Total Marks**		**200**	

SEMESTER IV

SI No	Subject Code	Course Title	No of Credits				Marks Allocated					Exam duration
			L	T	P	Total	CIE MIN	CIE MAX	SEE MIN	SEE MAX	Total	
1	MAL41P	Project Work (Phase – II)	-	-	-	18	50	100	150	300	400	
		TOTAL	-	-	-	**18**	**Total Marks**				**400**	

Subject Name & Code	Linear Algebra - ECPGM11
No. of Teaching Hours – 40	Credits: 3:0:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Solve systems of linear equations and homogeneous systems of linear equations by different methods
2. Obtain solutions for signal processing applications using vector space concepts
3. Explain the concept of a linear transformation as a mapping from one vector space to another.
4. Apply the concepts of factorization, SVD and Optimization to formulate and solve engineering problems.
5. Communicate and understand mathematical statements, ideas and results both verbally and in writing with correct use of mathematical definitions, terminology and symbolism by working collaboratively.

Unit 1

Linear equations: Fields; system of linear equations, and its solution sets; elementary row operations and echelon forms; matrix operations; invertible matrices, LU-factorization.

Vector spaces: Vector spaces; subspaces; bases and dimension; coordinates; summary of row-equivalence; computations concerning subspaces.

08 Hours

Unit 2

Linear Transformations: Algebra of linear transformations; isomorphism; representation of transformations by matrices; linear functional; transpose of a linear transformation.

08 Hours

Unit 3

Canonical Forms: Characteristic values; annihilating polynomials; invariant subspaces; direct-sum decompositions; invariant direct sums; primary decomposition theorem; cyclic bases; Jordan canonical form. Iterative estimates of characteristic values.

08 Hours

Unit 4

Inner Product Spaces: Inner products; inner product spaces; orthogonal sets and projections; Gram-Schmidt process; QR-factorization.

08 Hours

Unit 5

Symmetric Matrices and Quadratic Forms: Digitalization; quadratic forms; singular value decomposition.

08 Hours

References:

1. **Gilbert Strang,** "*Linear Algebra and its Applications*," 3rd Edition, Thomson Learning Asia, 2003.
2. **Kenneth Hoffman and Ray Kunze**, "*Linear Algebra*," 2nd Edition, Pearson Education (Asia) Pvt. Ltd/ Prentice Hall of India, 2004.
3. **David C. Lay**, "*Linear Algebra and its Applications*," 3rd Edition, Pearson Education (Asia) Pvt. Ltd, 2005.
4. **S. K. Jain and A. D. Gunawardena,** "*Linear Algebra, An Interactive Approach*," Thomson, Brooks/Cole, 2004.
5. **Bernard Kolman and David R. Hill**, "*Introductory Linear Algebra with Applications*," Pearson Education (Asia) Pvt. Ltd, 7th edition, 2003.

Subject Name & Code	**Graph Theory - ECPGM12**
No. of Teaching Hours – 40	**Credits: 3:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Comprehend the basic of Graph and trees and mathematical enumeration of trees using various formulations.
2. Describe the basics of Tree as data structure and types of trees,
3. Applications of bipartite graph, Euler's graph, Hamiltonian graphs.
4. Demonstrate the applications of k-connected networks, k-connected graphs, maximum flow networks, stable matching.
5. Implementation of various Vertex coloring, theorems and its application.

Unit 1

Introduction: Discovery of graphs, Definitions, Subgraphs, Isomorphic graphs, Matrix representations of graphs, Degree of a vertex, directed walks, paths and cycles, Connectivity in digraphs, Eulerian and Hamilton digraphs, Eulerian digraphs, Hamilton digraphs, Special graphs, Complements, Larger graphs from smaller graphs, Union, Sum, Cartesian Product, Composition, Graphic sequences, Graph theoretic model of the LAN problem, Havel-Hakimi criterion, Realization of a graphic sequence.

08 Hours

Unit 2

Connected graphs and shortest paths: Walks, trails, paths, cycles, connected graphs, Distance, Cut-vertices and cut-edges, Blocks, Connectivity, Weighted graphs and shortest paths, Weighted graphs, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm.

08 Hours

Unit 3

Trees: Definitions and characterizations, Number of trees, Cayley's formula, Kircho-matrix-tree theorem, Minimum spanning trees, Kruskal's algorithm, Prim's algorithm, Special classes of graphs, Bipartite Graphs, Line Graphs, Chordal Graphs, Eulerian Graphs, Fleury's algorithm, Chinese Postman problem, Hamilton Graphs, Introduction, Necessary conditions and sufficient conditions. **08 Hours**

Unit 4

Independent sets coverings and matchings: Introduction, Independent sets and coverings: basic equations, Matchings in bipartite graphs, Hall's Theorem, K¨onig's Theorem, Perfect matchings in graphs, Greedy and approximation algorithms.

08 Hours

Unit 5

Vertex Colorings: Basic definitions, Cliques and chromatic number, Mycielski's theorem, Greedy coloring algorithm, Coloring of chordal graphs, Brooks theorem, Edge Colorings, Introduction and Basics, Gupta-Vizing theorem, Class-1 and Class-2 graphs, Edge-coloring of bipartite graphs, Class-2 graphs, Hajos union and Class-2 graphs, A scheduling problem and equitable edge-coloring.

08 Hours

References:

1. **J. A. Bondy and U. S. R. Murty**. "*Graph Theory*", volume 244 of Graduate Texts in Mathematics. Springer, 1st edition, 2008.
2. **J. A. Bondy and U.S.R. Murty,** "*Graph Theory with Applications*" https://www.iro.umontreal.ca/~hahn/IFT3545/GTWA.pdf
3. **West. D. B**, "*Introduction to Graph Theory*", Prentice Hall, Upper Saddle River, NJ.
4. **Narasingh Deo, "***Graph Theory with application to engineering and computer science*," Prentice-Hall. (E-book is available).
5. Lecture Videos: http://nptel.ac.in/courses/111106050/13.

Subject Name & Code	**Data Analytics - ECPGM13**
No. of Teaching Hours – 40	**Credits: 3:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Understand the basic principles and classification techniques of data analysis Model.
2. Apply machine learning, statistics, visualization, algorithm, database technologies in data mining applications.
3. Develop a data mining application for data analysis using various tools.
4. Demonstrate the applications of neural networks.
5. Implementation of various map reduce techniques in Hadoop environment.

Unit 1

Data Analysis: Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics – Rule induction.

08 Hours

Unit 2

Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, Stochastic search methods.

08 Hours

Unit 3

Mining Data Streams: Introduction to Streams Concepts – Stream data model and architecture – Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream– Estimating moments – Counting oneness in a window – Decaying window – Realtime Analytics Platform (RTAP) applications – case studies – real time sentiment analysis, stock market predictions. **08 Hours**

Unit 4

Frequent Item Sets and Clustering: Mining Frequent item sets – Market based model – A priori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent item sets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Frequent pattern-based clustering methods – Clustering in non-Euclidean space – Clustering for streams and Parallelism.

08 Hours

Unit 5

Frameworks and Visualization: Map Reduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases – S3 – Hadoop Distributed file systems – Visualizations – Visual data analysis techniques, interaction techniques; Systems and applications.

08 Hours

References:

1. **Michael Berthold, David J. Hand,** "*Intelligent Data Analysis*", Springer, 2007.
2. **Bill Franks, Taming the Big Data Tidal Wave**: "*Finding Opportunities in Huge Data Streams with advanced analytics*", John Wiley & Sons, 2012.
3. **Glenn J. Myatt**, "*Making Sense of Data*", John Wiley & Sons, 2007.
4. **Pete Warden**, "*Big Data Glossary*", O'Reilly, 2011.
5. **Jiawei Han, Micheline Kamber,** "*Data Mining Concepts and Techniques*", Second Edition, Elsevier, Reprinted 2008.

Subject Name & Code	**Transform Techniques - ECPGM14**
No. of Teaching Hours – 40	**Credits: 3:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Identify system properties based on impulse response and Fourier analysis.
2. Apply transform techniques to analyze continuous-time and discrete-time.
3. Analyze the spectral characteristics of signals using Fourier analysis.
4. Demonstrate the applications of DFT & IDFT.
5. Implementation of convolution techniques in time domain and frequency domain.

Unit 1

Fourier Transform: The direct and inverse FT, existence of FT, Properties of FT, The Frequency Spectrum. **Laplace Transform:** The direct LT, Region of convergence, existence of LT, properties of LT. The inverse LT, Solution of differential equations, system transfer function. Linear Convolution: Graphical interpretation, properties of convolution, Correlation: Auto and Cross correlation, graphical interpretation, properties of correlation.

08 Hours

Unit 2

Discrete-time signals and systems: Sampling, classification of DT signals, Discrete-time energy and power signals, Linear Shift invariant systems, Stability and Causality, Linear constant coefficient systems, Frequency domain representation of discrete time systems and signals.

08 Hours

Unit 3

Linear Convolution: Graphical interpretation, properties of convolution. Correlation: Auto and Cross correlation, graphical interpretation, properties of correlation.

08 Hours

Unit4

Z-Transform: The direct ZT, Region of convergence, Z-plan e and S-plane correspondence. Inverse ZT, Properties of Z-transforms, Solution to linear difference equations, System transfer function.

08 Hours

Unit 5

Discrete Fourier series, Sampling the z-transform, Discrete Time Fourier Transform (DTFT), properties of DTFT, Discrete Fourier Transform (DFT), properties of DFT, Linear convolution using DFT.

08 Hours

References:

1. **B.P. Lathi**, "*Signals, Systems and Communication"*, BS Publications, 2006.
2. **Luis F. Chaparro**, "*Signals and Systems using MATLAB"*, Academic press, 2011
3. **Alan V. Oppenheim and Ronald W. Schafer**, "*Digital Signal Processing"*, PHI, 2008.

Subject Name & Code	Object Oriented Programming Using JAVA - ECPGM15
No. of Teaching Hours – 40	Credits: 3:0:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Explain the behavior of programs involving the fundamental concepts.
2. Analyze and develop programs on object-oriented concepts.
3. Apply the knowledge of exceptions and collections in java programming
4. Design the Java applications using threads and networking.
5. Demonstrate the Java programming skills in the analysis and simulation using various IDE tools.

Unit 1

Object Oriented Programming Concepts– Abstraction – objects and classes – Encapsulation-Inheritance – Polymorphism.

08 Hours

Unit 2

An Introduction to Java, The Java Programming Environment, Fundamental Programming Structures in Java-Overview of Java, Datatypes, operators, String handling, Wrapper classes, Control statements

08 Hours

Unit 3

Objects and Classes, Inheritance, Inner Classes, Packages and Interfaces, Streams.

08 Hours

Unit 4

Exception Handling -Exception-Handling Fundamentals, Exception Types, Using try and catch, Java's Built-in Exceptions, User Defined exceptions.

Multithreading–Java Thread model, creating a Threads, Creating Multiple Threads, Thread Priorities, Thread Synchronization, Inter-thread Communication, Thread life cycle.

08 Hours

Unit 5

Collections- Collections Overview, The Collection Interfaces, The Collection Classes, Accessing a Collection via an Iterator, Sets, Lists, Maps, Vector Class

JDBC- JDBC Driver Types; JDBC Packages; Database Connection; Associating the JDBC/ODBC Bridge with the Database; Statement Objects; Result Sets

08 Hours

SLE Components: RMI: Remote Method Invocation concept; Server side, Client side, Servlets programming, Networking

References:

1. **Cay S Horstmann**, *Core Java Volume I--Fundamentals ,9th Edition, Core Series*, November 2012.
2. **Cay S Horstmann**, *"Core Java, Volume II--Advanced Features" ,9th Edition, (Core Series*) by, Prentice Hall March, 2013.
3. **Herbert Schildt** , *"Java: The Complete Reference",* Mcgraw-Hill Osborne Media, 10th edition, 2014.

NPTEL Course:

1. http://nptel.ac.in/courses/106106147/3
2. https://onlinecourses.nptel.ac.in/noc19_cs07/preview
3. https://nptel.ac.in/courses/106105084/28

Subject Name & Code	Advanced Microcontrollers and applications - ECPGM16
No. of Teaching Hours – 40	Credits: 3:0:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Distinguish Types of computers & microcontrollers,
2. Construct Real Time Applications of Microcontrollers.
3. Demonstrate RTOS for Microcontrollers.
4. Translate Hardware applications using Microcontrollers.
5. Implement various hardware experiments using LCD, keyword, 7 segment display and verify the results.

Unit 1

Overview of Architecture & Microcontroller Resources: Architecture of a microcontroller – Microcontroller resources – Resources in advanced and next generation microcontrollers – 8051 Microcontroller – Internal and External memories – Counters and Timers – Synchronous serial-cum asynchronous serial communication – Interrupts.

08 Hours

Unit 2

8051- Microcontrollers Instruction Set: Basic assembly language programming – Data transfer instructions – Data and Bit-manipulation instructions – Arithmetic instructions – Instructions for Logical operations on the test among the Registers, Internal RAM, and SFRs – Program flow control instructions – Interrupt control flow.

08 Hours

Unit 3

Real Time Control: Interrupts: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – non-maskable interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051. Timers: Programmable Timers in the

MCU's – Free running counter and real time control – Interrupt interval and density constraints.

08 Hours

Unit 4

Systems Design: Digital and Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings – LED and Array of LEDs – Keyboard-cum-Display controller (8279) – Alphanumeric Devices – Display Systems and its interfaces – Printer interfaces – Programmable instruments interface using IEEE 488 Bus – Interfacing with the Flash, Analog input interfacing – Analog output interfacing – Optical motor shaft encoders – Industrial control – Industrial process control system – Prototype MCU based Measuring instruments.

08 Hours

Unit 5:

Real Time Operating System for Microcontrollers: Real Time operating system – RTOS of Keil (RTX51) – Use of RTOS in Design – Software development tools for Microcontrollers. 16-Bit Microcontrollers: Hardware – Memory map in Intel 80196 family MCU system – IO ports – Programmable Timers and High-speed outputs and input captures – Interrupts – instructions. ARM 32 Bit MCUs: Introduction to 16/32 Bit processors – ARM architecture and organization – ARM Thumb programming model – ARM / Thumb instruction set – Development tools.

08 Hours

References:

1. **Raj Kamal**, "*Microcontrollers Architecture, Programming, Interfacing and System Design*"– Pearson Education, 2005.
2. **Mazidi and Mazidi**, "*The 8051 Microcontroller and Embedded Systems*" – PHI, 2000.
3. **A.V. Deshmuk**, "*Microcontrollers (Theory & Applications)*" – WTMH, 2005.
4. **John B. Peatman**, "*Design with PIC Microcontrollers*" – Pearson Education, 2005.

Subject Name & Code	Mathematical Modeling and Simulation - ECPGM17
No. of Teaching Hours – 40	Credits: 3:0:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Formulate various mathematical models based on modeling tools and techniques.
2. Derive and use various simulation techniques.
3. Simulate examples based to realistic models using appropriate modeling tools.
4. Implement statistical simulation for various models and view the control simulations and their results.

Unit 1

Mathematical Modeling: Modeling and its principles, some methods of mathematical modeling: problem definition, dimensional homogeneity and consistency, abstraction and scaling, conservation and balance principles, system characterization, constructing linear models, discrete versus continuous modelling, deterministic versus stochastic.

08 Hours

Unit 2

Approximating and Validating Models: Review of Taylor's formula and various trigonometric expansions, validating the model, error analysis, fitting curves to the data.

08 Hours

Unit 3

Basic Simulation Approaches: Methods for simulation and data analysis using MATLAB, statistics for simulations and analysis, random variates generation, sensitivity analysis.

08 Hours

Unit 4

Model and its Different Types: Linear and nonlinear population models, traffic flow models, transport phenomena, diffusion and air pollution models, statistical models, Poisson process, stochastic models, computer data communications, stock market, option pricing, Black-Scholes model, modeling engineering systems.

08 Hours

Unit 5

Software Support: MATLAB, **Experiment**: Implementation of numerical techniques using MATLAB based on course contents. Projects: The projects will be assigned according the syllabus covered.

08 Hours

References:

1. **Clive L. Dym, "***Principles of Mathematical Modelling*", Elsevier Press, Second Edition, 2004.
2. **Edward A. Bender,** *An Introduction to Mathematical Modeling***, Dover, 2000.**
3. **D Kincaid and W. Cheney,** *Numerical Analysis: Mathematics of Scientific Computing***,**
4. *American Mathematical Society***,** Third Edition, 2009.

Subject Name & Code	Technical report writing and documentation - ECPGM21
No. of Teaching Hours – 30	Credits: 2:0:0 L-T-P
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Describe technical report formats and standard practices using LaTeX software.
2. Prepare technical papers according to standard IEEE guidelines applying LaTeX commands.
3. Develop project report, technical presentations, seminars and analyze case studies.
4. Work in a group to prepare and present project report, publications using online software tools.

Unit 1

Report formats and introduction to LaTeX: Introduction basic concepts of report format and standard practice of learning LaTeX. Related exercises.

06 Hours

Unit 2

IEEE guidelines: Preparation of technical/research papers according to the standard IEEE guidelines.

06 Hours

Unit 3

Report writing and presentations: Guidelines for project report writing, differences between technical presentations and seminars**.**

06 Hours

Unit 4

Technical literature and report writing: Introduction to technical writing and technical literature survey.

06 Hours

Unit 5

Case studies and exercises: Case studies on report writing, presentations, seminars and related exercises. **06 Hours**

References:

1. **C.R. Kothari and Gaurav Garg**, "Research Methodology Methods and Techniques" 4th Edition, New Age International (P) Ltd, Reprint 2019.
2. "A guide to technical report writing", the IET (Institution of Engineering and Technology). 2015.

E-Resources

1. **https://nptel.ac.in/content/storage2/courses/121106007/Week1/LiteratureSurveyWritingUp.pdf**

Subject Name & Code	Research Methodology - ECPGM22
No. of Teaching Hours – 30	Credits: 2:0:0 L-T-P
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Describe the carried out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
2. Explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
3. Apply the details of sampling designs, measurement and scaling techniques and also different methods of data collections.

Unit 1

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, inductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process,

Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

06 Hours

Unit 2

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.

06 Hours

Unit 3

Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

06 Hours

Unit 4

Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

06 Hours

Unit 5

Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

06 Hours

References:

1. **Donald Cooper & Pamela Schindler**, "*Business Research Methods* ", TMGH, 9th edition.
2. **Alan Bryman & Emma Bell**, "*Business Research Methods*", Oxford University Press.
3. **C.R.Kothari,** " *Research Methodology: Methods and Techniques*", New Age International Publisher, 2019.

Subject Name & Code	**Sustainable Technologies - ECPGM23**
No. of Teaching Hours– 30	**Credits: 2:0:0 L-T-P**
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Understanding of the whole issue of "Sustainability" and its critical relevance for future managers and professionals.
2. Demonstrate an integrated approach in evaluating performances of business, organizations and individuals by taking into account both the positive and negative impact on economic, social and environmental systems.
3. Analyze the methods of synthesize multi-dimensional, hierarchical and quasi-quantitative information.

Unit 1

Introduction to technology, sustainability and sustainable development - Technology; concepts and definitions; Concepts of sustainability and sustainable development; Components of sustainability (Social, Economic, Environmental)

06 Hours

Unit 2

Linkages between resource use, technology and sustainability - Interactions between energy and technology, and their implications for environment and sustainable development; Technology diffusion and commercialization; Business and sustainability.

06 Hours

Unit 3

Measuring and Benchmarking Sustainability - Sustainability proofing; Frameworks for measuring sustainability; Indicators of sustainability.

06 Hours

Unit 4

Sustainability transitions "Technologies and Economic sectors/systems; Sustainability transition.

06 Hours

Unit 5

"Case Studies; Sustainable innovations "Drivers and Barriers; Policy and institutional innovations for sustainability transition.

06 Hours

References:

1. **Dorf, Richard C**., Technology, humans, and society: toward a sustainable world, Academic Press, 2001.
2. **Rogers, P.P., Jalal, K.F. and Boyd, J.A**., An Introduction to Sustainable Development, Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.
3. **Weaver, P., Jansen, L., Grootveld, G.V., Spiegel, E.V. and Vergragt, P**., Sustainable Technology Development, Greenleaf Publishing, Sheffield, 2000.
4. **Grubler, A.,** Technology and Global Change, Cambridge University Press, Cambridge, 2003.

Subject Name & Code	**Social Implications of Technology - ECPGM24**
No. of Teaching Hours – 30	**Credits: 2:0:0 L-T-P**
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Understand the effects of technology on society.
2. Develop strategies for using and managing of technologies in our daily life.
3. Apply the strategies to reduce the social implications on new technologies.

Unit1

The relationship between technology and society: The Social Construction of Facts and Artifacts, The Intersection of Culture, Gender, And Technology

06Hours

Unit 2

Technology and values: Amish Technology: Reinforcing Values and Building Community Manufacturing Gender in Commercial and Military Cockpit Design.

06Hours

Unit 3

The complex nature of sociotechnical systems: Sociotechnical Complexity: Redesigning A Shielding Wall Bodies, Machines, And Male Power.

06Hours

Unit 4

Visions of a technological future: Technology and Social Justice**,** Nanotechnology: Shaping the World Atom By Atom.

06Hours

Unit 5

Twenty-first-century challenges: Energy, Society, And Environment: Technology for A Sustainable Future People's Science in Action: The Politics of Protest and Knowledge Brokering in India.

06Hours

Reference:

1. **Deborah G. Johnson and Jameson M. Wetmore**, "*Technology and society: building our sociotechnical future*", Massachusetts Institute of Technology, 2009.
2. Study articles related to above topics (IEEE transactions).

Subject Name & Code	**Entrepreneurship and Management - ECPGM25**
No. of Teaching Hours – 30	**Credits: 2:0:0 L-T-P**
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Explain entrepreneurship, management and innovation with an emphasis on their evolution. Identify various institutional support for starting new business, assessment of demand and supply in potential areas of growth, opportunity identification and feasibility analysis.
2. Analyze the importance of technology management with respect to organizational finance, ethics, team work and project planning. Investigate techno-economic feasibility of a project.
3. Identify the outcomes of innovation with regard to IPR and patents in technology-oriented business.
4. Assess various successful entrepreneurial profiles, analyze the startup ecosystem and new venture creations, working in teams study case examples, develop a business plan, prepare a report, and critically evaluate.

Unit 1

Introduction to Innovation: Creativity, Invention and innovation, Types of Innovation, Relevance of Technology for Innovation, The Indian innovations and opportunities, Strategy for Commercializing Innovation: Innovation Process, Risks and barriers for introducing products and services, selecting a Strategy, setting up the Investment and establishing organization, Evaluating the Costs and impact of the Project.

06 Hours

Unit 2

Entrepreneurship: Concept, meaning, need and competencies/qualities/traits of an entrepreneur, Technopreneurship. Innovation: Introduction, motivating to innovate, introduce core ideas about how to think about innovation, including key theories about factors that affect innovation. An in-depth review of how companies' structure to encourage and develop innovation. Product development and design.

06 Hours

Unit 3

Role of financial institutions: Role of financial institutions in entrepreneurship development and support Institutes: District Industry Centers (DICs), State Financial Corporations, Small Industries Service Institutes (SISIs), Small Industries Development Bank of India (SIDBI), National Small Industries Corporation (NSIC) and other relevant institutions.

06 Hours

Unit 4

Engineering Management: Introduction to Engineering Management: Engineering and Management, historical development of engineering management. Functions of management: planning and forecasting, decision making, organizing, motivating and leading technical people, controlling.

Technology management: Managing projects: Project planning and acquisition, organization and types, leadership and control. Case Studies.

06 Hours

Unit 5

Project Report Preparation: Preliminary report, Techno-economic feasibility report, Project viability. Market Survey and Opportunity Identification: start-up industry, procedures for registration of industry. assessment of demand and supply in potential areas of growth, understanding business opportunity, considerations in product selection and development, data collection for setting up new ventures. Case studies examples.

06 Hours

Reference:

1. **Peter Duckers, "**Innovation and Entrepreneurship Practice and Principles", Heinnemann, 1985.
2. **Morse and Babcock, "**Managing Engineering and Technology", 4th edition, PHI Learning Private Limited, New Delhi, 2009.
3. **Rabindra N. Kanungo** "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.
4. **Peter F. Drucker**, "Innovation and Entrepreneurship

Subject Name & Code	Electronic Waste management - ECPGM26
No. of Teaching Hours – 30	Credits: 2:0:0 L-T-P
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Understand about the environmental impacts of e-waste.
2. Apply various concept learned under e-waste management hierarchy.
3. Distinguished the role of various national and internal act and laws applicable for e-waste management and handling.
4. Analyze the e – waste management measures proposed under national and global legislations.

Unit 1

Introduction to E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management.

06 Hours

Unit 2

Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India.

06 Hours

Unit 3

E-waste hazardous on Global trade: Essential factors in global waste trade economy, Waste trading as a quint essential part of electronic recycling, Free trade agreements as a means of waste trading. Import of hazardous e-waste in India; India's stand on liberalizing import rules, E-waste economy in the organized and unorganized sector. Estimation and recycling of e-waste in metro cities of India.

06 Hours

Unit 4

E-waste control measures: Need for stringent health safeguards and environmental protection laws in India, Extended Producers Responsibility (EPR), Import of e-waste permissions, Producer-Public-Government cooperation, Administrative Controls & Engineering controls, monitoring of compliance of Rules, Effective regulatory mechanism strengthened by manpower and technical expertise, Reduction of waste at source.

06 Hours

Unit 5

E- waste legislation: E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016 - Salient Features and its likely implication. Government assistance for TSDFs. The international legislation: The Basel Convention.

06 Hours

References:

1. **Hester R.E., and Harrison R.M**, "*Electronic Waste Management. Science*", 2009.
2. **Fowler B.** "*Electronic Waste* (Toxicology and Public Health Issues)". 1st Edition, Elsevier, 2017.
3. **Johri R**., "*E-waste: implications, regulations, and management in India and current global best practices*", TERI Press, New Delhi.

Subject Name & Code	**Internet and Society - ECPGM27**
No. of Teaching Hours – 30	**Credits: 2:0:0 L-T-P**
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Describe the relations between technology and social change, power disparities, democracy, surveillance, work and participation.
2. demonstrate a basic understanding of how the internet and social media have been analysed sociologically, and independently grasp theoretical debates in the field of digital sociology.
3. Apply the technique in research of digital sociology.

Unit 1

Digital society, social media, Cyber Debates, Interaction and Identity, Communication and Networks.

08 Hours

Unit 2

Digital visuality and visibility, Feeling Digital, Digital Citizenship and Digital power and Exploitation.

08 Hours

Unit 3

Digital activism, mobile culture, software, algorithms and Data, Digital Social research, the research process.

08 Hours

Unit 4

Tools: Digital Ethnography, Mapping and mining digital Society, A Theory of digital media and social changes.

06 Hours

References:

1. **Lindgren Simon, "**Digital media and society: theories, topics and tools", SAGE Publications, 2017.

Subject Name & Code	Hybrid Electric Vehicles – MAL110
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Objectives: At the end of the course the students will be able to;

1. Explain the knowledge of fundamental concepts, principles, and history of Hybrid and Electric vehicles.
2. Analyse the architectures of Hybrid and Electric Vehicles.
3. Analyze the Electrical Machines for Hybrid and Electric Vehicles.
4. Understand the energy storage elements like rechargeable battery types, energy storage devices and battery parameters.
5. Analyse the Control System for Electric and Hybrid Electric Vehicles.

Unit 1:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. **10 Hours**

Unit 2:

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive- train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. **10 Hours**

Unit 3:

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives,

Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

12 Hours

Unit 4:

Energy Storage: Batteries in Electric and Hybrid Vehicles, Battery Basics and Parameters, Electrochemical Cell Fundamentals - electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Traction Batteries - lead acid batteries, nickel-based batteries, lithium-based batteries, and Ultra-capacitors. **10 Hours**

Unit 5:

Alternative and Novel Energy Sources and Stores: Solar Photovoltaic, Flywheels, and Fuel Cells - Hydrogen Fuel Cells, Fuel Cell Thermodynamics, Hydrogen storage system

10 Hours

References:

1. **Iqbal Hussein, "** *Electric and Hybrid Vehicles: Design Fundamentals*," CRC Press, 2003.
2. **Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi,** "*Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*," CRC Press, 2004.
3. **James Larminie, John Lowry,** "*Electric Vehicle Technology Explained, Wiley*," 2003.

Subject Name & Code	Digital control systems – MAL120
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, student will be able to,

1. Analyze discrete time signals and systems using z-transforms
2. Analyze discrete time systems and evaluate their time response using transfer function and state-space model
3. Evaluate the stability of discrete time systems using algebraic methods, root locus technique and frequency domain plots
4. Design digital controllers using classical tools such as root locus, bode plots
5. Carry out a group task making use of simulation and analytical tools, document and give an effective presentation.

UNIT 1

Basic digital control systems, examples of digital control systems, revision of Laplace and Z-Transforms, solution of difference equations, solution of state equations; recursive and Z-Transform methods, similarity transformation, sampling, ideal sampler, evaluation of $E^*(S)$, properties of $E^*(S)$, zero order hold, first order hold and their frequency response.

10 Hours

UNIT 2

Open loop discrete time systems, relation between $E^*(S)$ and E (Z), pulse transfer function, modified Z-Transforms, systems with time delays, closed loop systems, transfer function using signal flow graph and block diagram reduction, system time response, system characteristic equation, mapping from S-Plane to Z-Plane, steady state error.

12 Hours

Unit 3

Stability, Lyapnov's method, Routh-Hurwitz and Jury's stability tests, stability analysis using root locus technique, effects of adding poles and zeros, stability analysis in frequency domain; Bode plot and Nyquist's plot. **10 Hours**

UNIT 4

Realization of digital systems, control and observer canonical forms, Jordan canonical form, tests for controllability and observability, Design of Digital controllers; Phase lag, phase lead, lag-lead and PID controllers.

10 Hours

UNIT 5

Design of State Variable Feedback Controller and Observer for Discrete Time Systems.

10 Hours

Case studies: Servo motor system, environmental chamber control system, Air craft landing system, Neonatal fractional inspired oxygen, Latest works from two refereed journals of IEEE competence

References:

1. **Charles L. Phillips, H. Troy Nagle, Aranya Chakraborthy**, "*Digital Control Systems, Analysis and Design"*, 4th Edition, McGraw Hill, 2014.
2. **M. Gopal**, "*Digital Control and State Variable Methods*", Mc Graw Hill India, 2012
3. **Gene F. Franklin, J. David Powell and Michael Workman**, "*Digital Control of Dynamic Systems"*, 3rd Edition, Ellis-Kagle Press, 2006.
4. **John Dorsey**, "*Continuous and Discrete Control Systems, Modeling, Identification, Design and Implementation"*, McGraw Hill, 2002.
5. **Landau, Ioan Doré, Zito, Gianluca**, "*Digital Control Systems: Design, Identification and Implementation"*, Springer, 2006.

Subject Name & Code	**Automotive Software Engineering – MAL130**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, student will be able to,

1. Gather adequate knowledge in automotive software engineering, business life practices, contemporary issues and the global and societal effects of engineering practices on health, environment, and safety
2. To devise, select, and use modern techniques and tools needed for automotive electronic systems
3. To provide essential basics, processes, methods, and tools for the development, production, and service of software for automotive electronic systems

Unit 1

Introduction and Overview: Professional software development, Software Engineering Ethics, Software process models, Process, Activities, coping with change, The rational unified process, The Driver-Vehicle-Environment system, Overview of Vehicle Electronic systems, Overview of Logical system, Processes in vehicle development, Methods and Tools for the development of software for electronic systems **10 Hours**

Unit 2

Essential System Basics: Open-Loop and Closed-Loop Control systems, Discrete systems, Embedded systems, Real-Time systems, Distributed and Networked systems, System Reliability, Safety, Monitoring, and Diagnostics. **10 Hours**

Unit 3

Support Processes for Electronic Systems and Software Engineering: Basic definitions of system theory, Process models and standards, Configuration management, Project management, Subcontractor management, Requirements management, Quality assurance **10 Hours**

Unit 4

Core Processes for Electronic Systems and Software Engineering: Requirements and Prerequisites, Basic definitions and Notations, Analysis of User requirements and Specification of logical system architecture, Analysis of logical system architecture and specification of technical system architecture, Specification of Software components, Design and implementation of software components, Software component testing, Integration of software components, System integration test, Calibration, System and acceptance test. **12 Hours**

Unit 5

Methods and Tools for Development: Off board Interface between Electronic control units and tools, Analysis of logical system architecture and specification of technical system architecture, Specification of software functions and validation of specification, Design and implementation of software functions, Integration and Testing of software functions, Calibration of software functions **10 Hours**

References:

1. **Jorg Schauffele and Thomas Zurawka**, "*Automotive Software Engineering Principles, Processes Methods and Tools*," SAE International Publishers
2. **Ian Sommerville**, "*Software Engineering*", Pearson, 9th Edition, 2011

Subject Name & Code	**Automotive Materials - MAL140**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, student will be able to,

1. Describe the integration of design, manufacturing and new technology applications in the automotive industry.
2. To evaluate automotive manufacturing techniques and designs for heat treatment
3. Apply the knowledge of automotive materials and structural design using metallic and Non-metallic materials and composites

Unit 1

Review Crystal structure: BCC, FCC and HCP structure, unit cell, crystallographic planes and directions, miller indices, crystal imperfections, point, line, planar and volume defects, Grain size, ASTM grain size number.

Constitution of alloys and phase diagrams: Constitution of alloys, Solid solutions, substitutional and interstitial, phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectroid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast-iron microstructure, properties and application. **12 Hours**

Unit 2

Heat treatment: Definition, Full annealing, stress relief, recrystallization and heroidizing normalizing, hardening and tempering of steel. Isothermal transformation diagrams, cooling curves superimposed on I.T. diagram CCR - Hardenability, Jominy end quench test, Austempering, martempering, case hardening, carburising, nitriding, cyaniding, carbonitriding, Flame and Induction hardening. **10 Hours**

Unit 3

Ferrous and non-ferrous metals: Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W) - stainless and tool steels, HSLA, maraging steels, Gray, White malleable, spheroidal -Graphite - alloy castirons. Copper and Copper alloys, Brass, Bronze and Cupronickel– Aluminium and Al-Cu – precipitation strengthening treatment, Bearing alloys. **10 Hours**

Unit 4

Non-metallic materials and composites: Polymers – types of polymers, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE Polymers – Urea and Phenol formal deliydes – Engineering Ceramics – Properties and applications of Al2O3, SiC, SiC, Si3, N4, PSZ and Sialon – Fibre and particulate reinforced composites. **10 Hours**

Unit 5

Mechanical properties and testing: Mechanism of plastic deformation, slip and twinning Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell) Impact test Izod and charpy, fatigue and creep test.

10 Hours

References:

1. **Kenneth G. Budinski and Michael K. Budinski**, "*Engineering Materials*," Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
2. **William D Callsber**, "*Material Science and Engineering*," John Wiley and Sons 1997.
3. **Raghavan. V. Materials** "*Science and Engineering*," Prentice Hall of India Pvt.Ltd., 1999.
4. **Sydney H. Avner** "*Introduction to Physical Metallurgy*", McGraw-Hill Book Company, 1994.

Subject Name & Code	**Digital control systems lab – MAL16L**
No. of Teaching Hours – 40	**Credits: 0:0:1.5 L-T-P**
CIE Marks: 50	

Course Outcomes: Using MATLAB/SIMULINK/dSpace tools, student will be to

1. Analyze first and second order digital control systems.
2. Model and analyze DC/AC motors commonly used in automotive systems.
3. Study and calibrate various sensors in automotive systems
4. Design and implement digital controller for simple motor models.

List of Experiments

1. Analysis of first and second order analog/digital systems using MATLAB/Simulink.
2. Determination of transfer function of DC/AC motor.
3. Design of controller using root-locus and bode plots for a DC/AC motor on MATLAB/Simulink.
4. Measurement of parameters such as proximity, pressure, temperature and calibration of appropriate sensors used in Automotives.
5. Design of controller and observer using state-space technique for position and velocity of DC motor MATLAB/Simulink.
6. Design of controller using state-space technique for position and velocity of brushless DC motor MATLAB/Simulink.
7. Light illumination control using dSpace tools.
8. Regular DC/Brushless DC motor control using dSpace tools.

References:

1. **J. P. Holman**, "*Experimental Methods for Engineers*," McGraw Hill Education, 2001.
2. **M. Gopal**, "*Digital Control and State Variable Methods*," McGraw Hill Education, 2012.
3. **Galip Ulsoy, Huei Peng, Melih Cakmakci**, "*Automotive Control Systems*," Cambridge University Press, 2012.

Subject Name & Code	**Design and Implementation Lab-I MAL17L**
No. of Teaching Hours – 40	**Credits: 0:0:1.5 L-T-P**
CIE Marks: 50	

In this course students are advised to conduct an extensive literature survey, to select an idea or conceptualize a functional block, design and implement the same test /analyses the design for its functionality, and prepare a report as well as an article, and give a demonstration.

Course Objectives

1. To generate new innovative interdisciplinary ideas/concepts in groups
2. To generate a methodology to realize the ideas.
3. To create a mathematical design and implementation the same (prototype development)
4. To carry out tests and Analysis (functionality test, performance analysis)
5. To prepare a Technical Report and write an article on the work for publishing (Local news print / Magazines/conferences)

Course outcome: During the course period, the student must be able to

1. Conduct literature survey, listing out the objectives and synopsis preparation
2. Develop a Mathematical model and design the required circuit
3. Demonstrate various modern tools usage, to carry out the chosen work
4. Perform demo as per specifications, and meeting the objectives: Report writing (consolidated) & Article writing (keeping target audience in mind)
5. To demonstrate skills related to group activity adhering to standard ethics

General Guidelines for conducting Design and Implementation Lab:

1. Generate the Ideas according to market/societal needs, the idea to implementable within 4-

months.

2. Refine the ideas suitably, create methodology, to materialize the ideas.
3. Design the complete circuit model
4. Develop functional blocks and to test them (functionality test)
5. Build prototype by integrating the sub blocks
6. Testing the functionality of the prototype (Testing)
7. Perform analysis of the circuit (Performance analysis)

NOTE

1. To promote group activity.
2. Group to accommodate minimum of 2 and maximum of 4 persons.
3. Group to generate project idea giving importance to its practicability.
4. Project can fall into any broad areas viz. Analog-Digital electronics/Digital signal processing/Microcontrollers and embedded systems/communication and networking etc. Sensors and controls etc.

Professional Electives

(I & II)

Professional Elective - I

Subject Name & Code	**Robotics and Automation - MAL141**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, the student should be able to

1. To study the various parts of robots and fields of robotics.
2. To study the various kinematics and inverse kinematics of robots.
3. To study the Euler, Lagrangian formulation of Robot dynamics.
4. To study the trajectory planning for robot.
5. To study the control of robots for some specific applications.

UNIT 1

BASIC CONCEPTS: Definition and origin of robotics, different types of robotics, various generations of robots, degrees of freedom, Asimov's laws of robotics, dynamic stabilization of robots. **10 Hours**

UNIT 2

POWER SOURCES AND SENSORS: Hydraulic, pneumatic and electric drives, determination of HP of motor and gearing ratio, variable speed arrangements, path determination, micro machines in robotics, machine vision, ranging, laser, acoustic, magnetic fiber optic and tactile sensors. **10 Hours**

UNIT 3

MANIPULATORS, ACTUATORS AND GRIPPERS: Construction of manipulators, manipulator dynamics and force control, electronic and pneumatic manipulator control circuits, end effectors, U various types of grippers, design considerations.

12 Hours

UNIT IV

KINEMATICS AND PATH PLANNING: Solution of inverse kinematics problem, multiple solution jacobian work envelop, hill climbing techniques, robot programming languages **10 Hours**

UNIT 5

Multiple robots, machine interface, robots in manufacturing and non- manufacturing applications, robot cell design, selection of robot. **10 Hours**

References:

1. **Mikell P. Weiss G.M., Nagel R.N., Odraj N.G**., "*Industrial Robotics*", McGraw-Hill Singapore, 1996.
2. **Ghosh**, "*Control in Robotics and Automation: Sensor Based Integration*," Allied Publishers, Chennai, 1998.
3. D**eb.S.R**., "*Robotics technology and flexible Automation*", John Wiley, USA 1992.
4. **Asfahl C.R**., "*Robots and manufacturing Automation,*" John Wiley, USA 1992.
5. **Klafter R.D., Chimielewski T.A., Negin M**., "*Robotic Engineering – An integrated approach,*" Prentice Hall of India, New Delhi, 1994.
6. **McKerrow P.J.,** "I*ntroduction to Robotics, Addison Wesley*," USA, 1991.

Subject Name & Code	**Automotive Transmission – MAL142**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Solve the different gear ratios for different gears in gear box system also to explain construction and working of fluid coupling.
2. Explain construction and working of planetary gear box, Ford T-model, Cotal and Wilson Gear box.
3. Illustrate the working principle of multi stage and polyphase torque converters, constructional and operational details of hydraulic transmission drives.
4. Illustrate the construction and working of automatic transmission and their merits and demerits
5. Explain the construction and working of typical hydrostatic drives and their advantages and disadvantages

UNIT 1

Gear Box: method of calculation of gear ratios for vehicles, performance characteristics in different speeds, different types of gear boxes, speed synchronizing devices, gear materials, lubrication.

Fluid coupling: advantages and limitations, construction details, torque capacity, slip in fluid coupling, performance characteristics. Means used to reduce drag torque in fluid coupling.

10 Hours

UNIT 2

All spur and internal gear type planetary gearboxes, Ford T-model, Cotal and Wilson Gear box, determination of gear ratios, automatic overdrives. **10 Hours**

UNIT 3

Principal of torque conversion, single, multi stage and polyphase torque converters, performance characteristics, constructional and operational details of typical hydraulic transmission drives (e.g.) Leyland, White Hydro torque drives. **12 Hours**

UNIT 4

Automatic transmission: Relative merits and demerits when compared to conventional transmission, automatic control of gears, study of typical automatic transmissions, Ford and Chevrolet drive, automatic control of gear box. **10 Hours**

UNIT 5

Hydrostatic drives: advantages and disadvantages, principles of hydrostatic drive systems, construction and working of typical hydrostatic drives, Janney Hydrostatic drive.

Electrical drives: Advantages and limitations, principles of Ward Leonard system of control Modern electric drive for buses and performance characteristics. **10 Hours**

References:

1. **Heldt P.M**, "*Torque converters*," Chilton Book Co.-1992
2. **Newton and Steeds,** "*Motor Vehicle*," Illiffee Publisher- 2000
3. "*Design Practices, passenger Car Automotive Transmissions*," SAE Hand book- 1994.

Subject Name & Code	**Advanced Embedded Systems – MAL143**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: After the completion of the course, student will be able to

1. Demonstrate the knowledge on basic hardware components and their selection methods based on the characteristics and attributes of an embedded system.
2. Explain the Hardware software co-design and firmware design approaches
3. Explain the Embedded hardware design and development using EDA Tool.
4. Demonstrate a comprehensive understanding of the instruction sets, assembly basics and memory mapping of ARM CORTEX M3.
5. Explain the operating System and Real Time Operating System for Embedded Design and Development

UNIT 1

Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components.

10 Hours

UNIT 2

Characteristics and Quality Attributes of Embedded Systems: Hardware Software Co- Design and Program Modeling: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language, Hardware Software Trade-offs. **10 Hours**

UNIT 3

Embedded Hardware Design and Development: EDA Tools, How to Use EDA Tool, Schematic Design – Place wire, Bus, port, junction, creating part numbers, Design Rules check, Bill of materials, Netlist creation, PCB Layout Design – Building blocks, Component placement, PCB track routing. **10 Hours**

UNIT 4

ARM -32 bit Microcontroller family and Embedded Firmware Design and Development: Architecture of ARM Cortex M3 –General Purpose Registers, Stack Pointer, Link Register,

Program Counter, Special Register, Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. Advanced Programming Features. Memory Protection. Debug Architecture. Embedded Firmware Design Approaches, Embedded Firmware Development Languages **12 Hours**

UNIT-V

Real-Time Operating System (RTOS) based Embedded System Design and Development Environment: Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting them altogether, Task Communication, Task Synchronization, Device Drivers, How to Choose an RTOS The Integrated Development Environment (IDE), Types of Files Generated on Cross compilation, Disassembler/ELD compiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan. **10 Hours**

References:

1. **Shibu K V**, "*Introduction to Embedded Systems*", Tata McGraw Hill Education Private Limited, 2009
2. **Joseph Yiu**, "*The Definitive Guide to the ARM Cortex-M3*", Newnes, (Elsevier), 2008.
3. **James K Peckol**, "*Embedded Systems – A contemporary Design Tool*," John Weily, 2008.

Professional Elective - II

Subject Name & Code	**Chassis and Body Electronics – MAL151**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: After the completion of the course, student will be able to

1. Illustrate the design and construction of chassis systems and tires
2. Explain steering and braking system in automobiles with emphasis on recent technologies
3. Explain the construction and working of suspension systems
4. Illustrate testing of major automobile components
5. Classify two and three wheelers and explain construction details of their components

Unit 1

Introduction to Chassis System: Introduction: Requirements of an automobile with types of automobiles, layout of an automobile with reference to power plant, power required for propulsion, various resistances to motion of the automobile. Frames: Types of frames, materials, calculation of stresses on sections, constructional details, loading points, testing of frames. Wheels and tyres: Types of wheels, construction. Structure and function of tyres.

10 Hours

Unit 2

Steering systems: Types of steering gears, front axle. Under steer and over steer, wheel alignment, power steering, steering geometry, wheel balancing, centre point steering, steerability.

Brakes: Necessity of brake, stopping distance and time. Brake efficiency, weight transfer, brake shoe theory, determination of braking torque, braking systems -mechanical, hydraulic, disc, parking and emergency brakes, servo and electrical brakes, details of hydraulic system, mechanical system and components. Types of master cylinders, factors influencing operation of brakes such as operating temperature, lining, brake clearance, pedal pressure, linkages etc.

12 Hours

Unit 3

Suspension: Types of suspension, leaf springs, materials, independent suspension, torsion bar, air

bellows or pneumatic, suspension, hydraulic suspension, constructional details of telescopic shock absorbers, types, vibrations and riding comfort, role axis of spring suspension.

10 Hours

UNIT 4

Front Wheel Mounting, Rear Wheel Mounting, engine mounting, various types of springs used in suspension system. Requirements and various types, Material. Testing: Testing procedures, types of tests and chassis components, equipment for lab and road tests, preparation of test reports. **10 Hours**

UNIT 5

Two and three wheelers: Classification of two and three wheelers, construction details, construction details of frames and forks, suspension systems and shock absorbers, different arrangement of cylinders. Carburetion system and operation. **10 Hours**

References:

1. **P. L. Kohli**, "*Automotive chassis and body*," TMH
2. **Sudhirkumar**, ***"****Automobile engineering*," university science press
3. **N.R. Khatawate** "*Introduction to automobile engineering*," Khanna publication.
4. **Joseph I heintner**, "*Automotive mechanics*," Affiliated East West Press
5. **N.K.Giri**, "Problems in Automobile Engineering," Khanna Publications
6. **P.M. Heldt**, "*Automotive Chassis*," Chilton & Co.

Subject Name & Code	**Vehicle Body Engineering and Safety – MAL152**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: After the completion of the course, student will be able to

1. Explain different car body details namely types, visibility, instrumentation etc.
2. Illustrate vehicle aerodynamics and to explain optimization techniques for minimum drag.
3. Explain different bus body details namely types, layout and constructional details.
4. Explain the construction and illustration of commercial vehicles and to explain body material types.
5. Explain importance of vehicle safety design and their concepts
6.

Unit 1

Car body details: Types: saloon, convertibles, limousine, estate car, racing and sports car. Visibility: regulations, driver's visibility, tests for visibility, methods of improving visibility and space in cars. Safety: safety design, safety equipment's for cars. Car body construction; design criteria, prototype making, initial tests, crash tests on full scale model, Dummies and Instrumentation **10 Hours**

UNIT 2

Vehicle aerodynamics: Objectives. Vehicle drag and types; various types of forces and moments, effects of forces and moments, side wind effects on forces and moments, Various body optimization techniques for minimum drag, wind tunnel testing: flow visualization techniques, scale model testing, component balance to measure forces and moments.

10 Hours

UNIT 3

Bus body details: Types: mini bus, single decker, double-decker, two level and articulated bus. Bus body layout; floor height, engine location, entrance and exit location, seating dimensions. Constructional details: frame construction, double skin construction, types of metal sections used, Regulations, Conventional and integral type construction. **10 Hours**

Unit 4

commercial vehicle details: Types of body; flat platform, drop side, fixed side, tipper body, tanker body, Light commercial vehicle body types. Dimensions of driver's seat relation to controls. Drivers cab design.

Body materials, trim and mechanisms: Steel sheet, timber, plastic, GRP, properties of materials; Corrosion, anticorrosion methods. Selection of paint and painting process, Body trim items. Body mechanisms. **12 Hours**

Unit 5

Safety design and concepts: Design of the body for safety, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction. Active safety: driving safety, conditional safety, perceptibility safety, operating safety- passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. **10 Hours**

References:

1. **J. Powloski**, "*Vehicle Body Engineering*," Business Books Ltd, London -1989
2. **Giles J Cm**, "*Body construction and design*," Liiffe Books Butterworth & Co. - 1971.
3. **John Fenton**, "*Vehicle Body layout and analysis*," Mechanical Engg. Publication Ltd., London 1982.
4. **Braithwaite J B**, "*Vehicle Body building and drawing*," Heinemann Educational Books Ltd., London – 1977.

II Semester Syllabus

Subject Name & Code	**Autotronics - MAL210**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Objectives: At the end of the course the students will be able to;

1. Examine the operation of the ICE fuel injection and ignition system.
2. Exemplify the measuring principles involved in sensors and evaluate for automotive applications
3. Exhibit the knowledge of working of power converters and vehicular communication systems.
4. Work efficiently as an individual and complete the assigned task by demonstrating skills related to documentation and oral communication.

Unit 1:

Electronic fuel injection and ignition system: Introduction -Fuel System Components-Electronic Fuel System-Fuel Injection-Types-Throttle Body Versus Port Injection-Electronic Control Fuel Injection-Operation-Different Types-Fuel Injectors-Idle Speed Control-Continuous Injection System-High Pressure Diesel Fuel Injection -MPFI System - Electronic Ignition System-Operation-Types-Electronic Spark Timing Control. **10 Hours**

UNIT 2:

Automotive sensors: Position Sensors, Speed and Rpm Sensors, Acceleration Sensors, Pressure Sensors, Force and Torque Sensors, Flowmeters, Temperature Sensors, Engine-Speed Sensors, Hall Phase Sensors, Speed Sensors for Transmission Control, Wheel- Speed Sensors, Micromechanical Yaw-Rate Sensors, Piezoelectric "Tuning-Fork" Yaw-Rate Sensor.

10 Hours

UNIT 3:

Vehicle motion control systems: Cruise Control System, Cruise Control Electronics, ABS, Electronic Suspension System, Electronic Steering Control, TCS, ESP and Adaptive Lighting System. **10 Hours**

UNIT 4:

Power converters: Overview of Elementary Power Converter Switches and Power Converters (Non-Isolated): BJT, Thyristors, MOSFETS, IGBT, IPM, IGCT. AC/DC Converters Single Phase and Three Phase: Line Commutated, Uncontrolled and Phase Controlled Converters (Half Bridge and Full Bridge) and Battery Management Systems. **12 Hours**

UNIT 5:

Automotive networking and bus systems: Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, Coupling of networks, Examples of networked vehicles, LIN Bus, Flex and MOST Bus architecture.

10 Hours

References:

1. **Willium B. Ribbens**, "*Understanding Automotive Electronics*," -Sixth edition Elsevier Science 2003
2. **Ronald K.Jurgen**," *Sensors and Transducers*," SAE 2003.
3. **Jack Erjavec, Robert Scharff**, "*Automotive Technology*," Delmar publications Inc 1992.

Subject Name & Code	Vehicle Engineering – MAL220
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Objectives: At the end of the course the students will be able to;

1. Explain the construction and working of different engine components and to review the cooling lubricating system.
2. Understand the working principle of various auxiliary systems
3. Develop the knowledge on different transmission mechanisms and their constructional details
4. Develop the knowledge on steering, suspension and braking systems.
5. Understand the different alternative energy sources available for the energy application in automobiles

Unit 1

Vehicle structure and engines: Types of Automobiles, Vehicle Construction, Chassis Frame and Body aerodynamics, Components of Engine their forms, Functions and Materials, Review of Cooling and lubrication systems in Engine, Turbo Chargers, Engine Emission Control by 3–Way Catalytic Controller, Electronic Engine Management System.

10 Hours

Unit 2

Engine auxiliary systems: Carburetor working principle, electronic fuel injection system, Mono-point and Multi – Point Injection Systems Construction, Operation and Maintenance of Lead Acid Battery, Electrical systems, Battery generator, Starting Motor and Drives Lighting and Ignition (Battery, Magneto Coil and Electronic Type) Regulators-cut outs. **10 Hours**

Unit 3

Transmission systems: Clutch, Types and Construction, Gear Boxes, Manual and Automatic Simple Floor Mounted Shift Mechanism, Over Drives Transfer Box Fluid flywheel -Torque convertors, Propeller shaft Slip Joint Universal Joints, Differential and Rear Axle Hotchkiss Drive and Torque Tube Drive. **12 Hours**

Unit 4

Steering, brakes and suspension: Wheels and Tyres – Wheel Alignment Parameters - Steering Geometry and Types of steering gear box Power Steering – Types of Front Axle – Suspension systems – Braking Systems – Types and Construction – Diagonal Braking System – Antilock Braking System. **10 Hours**

Unit 5

Alternative energy sources: Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles, Fuel cells. **10 Hours**

Note: Practical training in dismantling and assembling of Engine parts Transmission System should be given to the students

References:

1. **Sethi H.M**, "*Automobile Technology*," Tata McGraw-Hill-2003
2. **Kirpal Singh**, "*Automobile Engineering Vol. 1& 2*", Standard Publishers, New Delhi.
3. **Crouse and Anglin**, "*Automotive Mechanism*," 9th Edition. Tata McGraw-Hill, 2003.
4. **Newton, Steeds and Garet,** "*Motor vehicles*," Butterworth Publishers, 1989.
5. **Srinivasan S,** "*Automotive Mechanics*" 2nd edition, 2003, Tata McGraw-Hill.
6. **Joseph Heitner**, "*Automotive Mechanics*," 2nd edition, East-West Press, 1999.

Subject Name & Code	Automotive Instrumentation – MAL230
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. To understand the philosophy of instrumentation concept applied to Automotive systems.
2. To understand the method of measurement of physical quantities, analyze the data & compute the uncertainty involved considering physical variables.
3. To develop Instrumentation systems involving parameters based on Force, Vibration, Temperature, Proximity, Displacement, Pressure.
4. To Understand & develop mathematical model of Instrumentation system based on concept of open & closed loop systems & to use the techniques, skills, and modern engineering tools necessary for engineering practice.
5. To develop Data acquisition system including communication protocols and to apply theory of metrology & understand mechanical measurement methods.

Unit 1

Basic concept of measurement, types of errors, standards, Device under calibration, calibration techniques, requirement of calibration laboratory, Analysis of measurement data, Uncertainty & Reporting the outcome of measurement process. **10 Hours**

Unit 2

Sensors, Actuators & systems. Static & Dynamic characteristics of sensors & systems including Frequency response, response time, damping, reliability. Generalized mathematical model of measurement system. Instrumentation system for measurement of Displacement, Strain, Vibration pressure, force & Torque Design of Instrumentation systems for a practical application using above sensors. Data acquisition systems using digital methods including PC based systems. **12 Hours**

Unit 3

Concept of open loop, closed loop control systems for a typical Instrumentation system. Mathematical analysis of first order & higher order systems for a typical practical Instrumentation system, Analysis of control system for a typical automobile. (Examples of

Engine, braking systems can be considered) **10 Hours**

Unit 4

Metrology: Standards, Slip gauges, Measurement of angles, tapers, threads. Mechanical inspection methods, Inspection of straightness, flatness, alignment & surface finish.

10 Hours

Unit 5

Specifying product features using mechanical, Pneumatic, Electronic & Optical methods. Use of Optical flats & Interferometer. **10 Hours**

References:

1. **J. Holman,** "*Experimental methods for engineers*," 6th edition, McGraw-Hill.
2. **B.C.Nakra, K.K. Choudhary,** "*Instrumentation, Measurement & Analysis*," TMH
3. **E.O. Doeblin,** "*Measurement systems, Application & Design*," 4th edition, McGraw-Hill.
4. **T.G.Beckwith, N.L.Buck& R.D. Martangoni,** "*Mechanical measurement*," 3rd edition, Narosa Publishing House.
5. **J W F Gallies, C R Shotbolt,** *"Metrology for Engineers,"*
6. **N Mathivanan**, "*PC based Instrumentation- Concepts &* practice," PHI.

Subject Name & Code	PLC's And Industrial Automation – MAL240
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Explain the construction, working and control strategies of Input, output and Power modules
2. Explain the evolution of Industrial communication and networking for a real PLC communication
3. Develop PLC program for low level industrial applications.
4. To design and program basic PLC circuits for entry-level PLC applications using use timer, counter, and other intermediate programming functions.

Unit 1

Introduction: What Is A PLC, Technical Definition Of PLC, What Are Its Advantages, Characteristic Functions of A PLC, Chronological Evolution Of PLC, Types Of PLC, Unitary PLC Modular PLC, Small PLC, Medium PLC, Large PLC, Block Diagram Of PLC, Input / Output (I/O) Section, Processor Section, Power Supply, Memory, Central Processing Unit, Processor Software / Executive Software, Multitasking, Languages, Ladder Language.

PLC Timers and Counters: Timer and Its Classification, Characteristics of PLC Timer, Functions in Timer, Resetting – Retentive and Non-Retentive, Classification of PLC Timer, On Delay, And Off Delay Timers, Timer-On Delay, Timer Off Delay, Retentive and Non-Retentive Timers, Format of a Timer Instruction. PLC Counter, Operation of PLC Counter, Counter Parameters, Counter Instructions. Overview, Count Up (CTU), Count Down (CTD).

12 Hours

Unit 2

Bit Logic Instructions: Introduction, Input and Output Contact Program, Symbols, Numbering System Of Inputs And Outputs, Program Format, Introduction To Logic, Equivalent Ladder Diagram Of AND Gate, Equivalent Ladder Diagram Of OR Gate, Equivalent Ladder Diagram Of NOT Gate, Equivalent Ladder Diagram Of XOR Gate, Equivalent Ladder Diagram Of NAND Gate, Equivalent Ladder Diagram Of NOR Gate, Equivalent Ladder Diagram to demonstrate De

Morgan Theorem, Ladder Design. **10 Hours**

Unit 3:

Advanced Instructions: Introduction, Comparison Instructions, Discussions on Comparison Instructions, Addressing Data Files, Format of Logical Address, Addressing Format for Micro Logic System, Different Addressing Types. Data Movement Instructions, Logical Instructions. Mathematical Instructions. Main Features of Mathematical Instructions. Special Mathematical Instructions, Scale with Parameters or SCP Instruction. Data Handling Instructions Main Features of Data Handling Instructions. Program Flow Control Instructions. Proportional Integral Derivative (PID) Instruction. **10 Hours**

Unit 4

Plc Input Output (I/O) Modules and Power Supply: Introduction, Classification Of I/O, I/O System Overview, Practical I/O System And Its Mapping, Addressing Local And Expansion I/O, Input-Output Systems, Direct I/O Parallel I/O Systems, Serial I/O Systems, Sinking And Sourcing, Sourcing and Sinking in PLC Interfacing, Discrete Input Module, Discrete DC Input Module, Discrete AC Input Module, Rectifier with Filter, Threshold Detection, Isolation, Logic Section, Specifications Of Discrete Input Module Discrete Output Modules, Advantages And Disadvantages Of Output Modules, Specifications Of Analog Input Module , Types Of Analog Input Module, Special Input Modules, Analog Output Module I/O Modules In Hazardous Locations, Power Supply Requirements Filters.

10 Hours

Unit 5

Industrial Communication and Networking: Introduction, Evolution of Industrial Control Process, Types Of Communication Interface, Types Of Networking Channels, Parallel Communication Interface. Serial Communication Interface, Synchronous and Asynchronous Transmissions Compared, Standard Interface, Different Recommended Standards Compared, Software Protocol, Industrial Network. Network Topology, Media Access Methods, Open System Interconnection (OSI), Network Model, Network Components, Control Network Issues, Advantage Of Standardized Industrial Network, Intelligent Devices, Industrial Network Bus Network, Device Bus Network Vs. Process Bus Network, Controller Area Network (CAN), Device net, Control net, Ethernet Protocol, AS-I Interface, FOUNDATION FIELDBUS,

Application Of Profibus For Real PLC Communication.

Industrial Automation: Introduction, Utility of Automation, General Structure of An Automated Process, Examples of Some Simple Automated Systems, Selection of PLC.

10 Hours

References:

1. **Madhuchhanda Mitra and Samarjit Sen Gupta, "***Programmable Logic Controllers (PLC)and Industrial Automation***,"** Penram International Publishing (India) Pvt. Ltd. 2007. ISBN: 81-87972-17-3.

Subject Name & Code	**Design of Mechanical Systems – MAL250**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: After the completion of the course, student will be able to

1. Apply basic stress and strain analysis techniques to design machine elements.
2. To learn to use standard practices in selection of materials to design machine elements.
3. Utilize standard failure theories and fatigue analysis to develop safety factors for machine elements.
4. To learn to use standard practices in design of automobile machine elements and standard data.
5. Function effectively within engineering work teams.

Unit 1

Design cycle, stress analysis and types of loads, theories of failure, Design for variable loads: Endurance limit, Good's man and Soderberg criteria, example problems. **10 Hours**

Unit 2

Design of shafts: Causes of failure, materials, ASME code, design of shafts for fatigue loading considering the rigidity and stiffness. Design of clutches and brakes- calculation of heat generation and heat dissipation. **12 Hours**

Unit 3

Gears: Gear tooth geometry, tooth systems, gear trains, design of spur gear, helical gear, bevel and worm gears from strength and wear considerations. **10 Hours**

Unit 4

Introduction to Flywheel, Flywheel design: Bearings and lubrications, hydrodynamic theory, selection Procedure of antifriction bearings and journal bearings. **10 Hours**

Unit 5

Hydrostatic bearings, design of Hydrostatic bearing, design factors, concept of concurrent and simultaneous engineering, example problems. **10 Hours**

References:

1. **Joseph Edward shigly**, "*Mechanical engineering design*," McGraw Hill, 11th edition
2. **P C Sharma and D K Aggrawal,** "*Machine design*," S.K. Kataria & Sons
3. **V B Bhandari,** "Design *of Machine Elements*," McGraw Hill Education India Private Limited, 4th edition

Subject Name & Code	**Computer Aided Design Lab - MAL26L**
No. of Teaching Hours – 40	**Credits: 0:0:1.5 L-T-P**
CIE Marks: 50	

Course Outcomes: After the completion of the course, student will be able to

1. Interpret the concepts of 2D and 3D drawings and create solid models and Create 3D models using various surface modeling commands.
2. Apply the given conditions and solve the problem using Analysis software.

List of Experiments:

1. **Solid Modelling of simple machine components using CAD packages:** Study of Solid Modeling Package. Solid Modeling of simple machine parts
2. **Surface modeling using CAD packages:** Study of surface modeling package. Surface modeling of simple components.
3. **Computer Aided Analysis:** Bars of constant cross section area, tapered cross section area and stepped bar Design a PID controller for DC Motor.
4. Trusses (Minimum 2exercises of different types).
5. Beams–Simply supported, cantilever, beams with point load, UDL, beams with varying load etc., (Minimum 6 exercises different nature).
6. Stress analysis of a rectangular plate with a circular hole.
7. Thermal Analysis –1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises of different types)

References:

1. **Ashok D. Belegundu, Tirupathi R. Chandrupatla,** "*Introduction to Finite Elements in Engineering*," 3rd Edition PHI, 2002.
2. **J N Reddy,** "*An Introduction to the Finite Element Method*," 3rd edition McGraw – Hill, 2005
3. **P N Rao,** "*CAD/CAM principles and applications*."
4. **Groover,** "*CAD/CAM*."

Subject Name & Code	**Design and Implementation Lab-II MAL27L**
No. of Teaching Hours – 40	**Credits: 0:0:1.5 L-T-P**
CIE Marks: 50	

Course Objectives:

1. To generate new innovative interdisciplinary ideas/concepts in groups
2. To create a mathematical design and implementation the same (prototype development)
3. To carry out tests and Analysis (functionality test, performance analysis)
4. To prepare a Technical Report and write an article on the work for publishing (Local news print / Magazines/conferences).

Course Outcomes: At the end of the course, the student should be able to

1. Conduct literature survey, listing out the objectives and synopsis preparation
2. Develop a Mathematical model and design the required circuit
3. Demonstrate various modern tools usage, to carry out the chosen work
4. Perform demo as per specifications, and meeting the objectives: Report writing (consolidated) & Article writing (keeping target audience in mind)
5. To demonstrate skills related to group activity adhering to standard ethics

General Guidelines for conducting Design and Implementation Lab:

1. Generate the Ideas according to market/societal needs, the idea to implementable within 4-months.
2. Refine the ideas suitably, create methodology, to materialize the ideas.
3. Design the complete circuit Model.
4. Develop functional blocks and to test them (functionality test)
5. Build prototype by integrating the sub blocks
6. Testing the functionality of the prototype (Testing)
7. Perform analysis of the circuit (Performance analysis)

NOTE

1. To promote group activity.
2. Group to accommodate minimum of 2 and maximum of 4 persons.
3. Group to generate project idea giving importance to its practicability.
4. Project can fall into any broad areas viz. Analog-Digital electronics/Digital signal processing/Microcontrollers and embedded systems/communication and networking etc. Sensors and controls etc.

Professional Elective III

Professional Elective III

Subject Name & Code	**Automotive Networking - MAL241**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Establish the need of Networking in an Automobile
2. Explain and analyze the principles and functionalities of various Automotive Communication Protocols (ACPs)
3. Design, simulate, emulate and analyze CAN and LIN based automotive embedded networks
4. Design ACP based In-Vehicle Networks (IVNs)
5. Proficiently use CANoe tool to develop IVN applications as well as to simulate, analyze and Troubleshoot ACP based IVNs

Unit 1

Basics of Data Communication Networks and Automotive Communication Protocols: Need for networks, Types of networks, Need for standards, TCP/IP model, Topologies, Error detection and correction mechanisms, Encoding schemes, Serial/parallel transmission, Bits, Baud and bandwidth, Synchronous and asynchronous, Need and benefits of IVN, Classes of IVN protocols, Multiplexed electrical systems, Vehicle multiplexing, Bitwise contention, Network elasticity, Error processing and management and Case Study **10 Hours**

Unit 2:

Controller Area Network (CAN) Protocol: History and foundation of CAN, CAN Applications, Main characteristics of CAN, CAN in OSI Reference Model, CAN Data Link Layer, Principles of data exchange in CAN, Arbitration, Data Frame, Remote Frame, Error detection and management in CAN, CAN physical Layer, Bit encoding, Bit timing and synchronization, Relationship between data rate and bus length, Single wire and twin wire media, CAN repeaters, Medium-to-medium gateway, Protocol handlers, Micro-controllers and line drivers, Time Triggered CAN (TTCAN), Comparison with other IVN protocols, CANoe based applications development **12 Hours**

Unit 3

CAN Higher Layer Protocols and LIN: CAN Higher Layer Protocols: CAN in Automation (CiA), CANopen, CANopen device model, CANopen features, DeviceNet, DeviceNet Model, Device Object Model, DeviceNet Features, SAEJ1939, SAE J1939 Reference Model, CAN Kingdom and Case Study Local Interconnect Network (LIN) Protocol: Introduction to LIN, LIN consortium, LIN specification, LIN features, Technical overview, Work flow concept, LIN operation, LIN frame format, Scheduling table, Network management of LIN cluster, LIN Transport Layer, LIN node configuration and identification. **10 Hours**

Unit 4

FlexRay and MOST Protocol: FlexRay Protocol: Future on board systems, Need for FlexRay, Origin of FlexRay, FlexRay consortium, FlexRay Objectives, FlexRay Features, Application requirements, Working of FlexRay, Network topologies, ECU architecture, Segment Configuration, Communication Cycles, FlexRay frame format, Timing of configuration protocol, Error control, and FlexRay core mechanisms, Coding and Decoding, Medium Access Control, Frame and Symbol Processing, Clock Synchronization, FlexRay Components, Comparison with other IVN protocols and Case Study, Media Oriented System Transport (MOST) Protocol: Emerging in car systems, Introduction to MOST, MOST goals, Features, Cables and Connectors, Data Types, Topology, Frame Format, Application Areas, System Description, Specification, Device Model, Device Implementation, Diagnostics and Case Study.

10 Hours

Unit 5

In Vehicle Network Diagnostics: Process of Automotive Fault Diagnostics, Fault Codes, Vehicle Systems (open-loop and closed-loop) On- and Off- Board Diagnostics, OBD-I, OBD-II, Engine Analyzers, Steps taken to diagnose a fault, Diagnostics Protocol-KWP2000, SAE-J1587, SAE-J1708 and Case Study **10 Hours**

References:

1. Gilbert Held, "*Inter- and Intra-Vehicle Communications*," CRC Press, 2007

2. Behrouz Forouzan, "*Data Communications and Networking,*" McGraw-Hill. 2003

3. Ronald k. Jurgen, "Automotive Electronics Handbook," McGraw-Hill. 1999

Subject Name & Code	Emission and Control - MAL242
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Develop the knowledge on engine maintenance, service and equipment's used for the same.
2. Develop the knowledge on chassis dive line maintenance in energy transmission mechanism
3. Explain the need and significance of maintaining and servicing of auxiliaries of different automobile components
4. Illustrate the mechanism of air pollution due to automobiles and their analysis
5. Explain the construction and working of different mechanisms to control exhaust emissions from automobiles.

Unit 1

Engine Maintenance: Engine troubles, effects & remedies, different major & minor services for engine, inspection and checking of components visually and dimensionally, reconditioning methods of engine components, engine tune-up, special tools & advanced equipment's.

10 Hours

Unit 2

Chassis Dive-line Maintenance: Maintenance, repair and servicing of clutches, Fluid flywheel, gear boxes, Automatic transmission, CVT unit, propeller shaft, differential unit, front axle and rear axle, suspension systems, servicing of brake systems- hydraulic, air systems, brake bleeding and brakes adjustments, maintenance and servicing of steering system-Manual & Power Steering system, wheel balancing, wheel alignment, maintenance of tyres, tyre rotation, frame defects, chassis frame alignment. **12 Hours**

Unit 3

Maintenance, servicing of auxiliaries: Cooling system service, anti-corrosion additives, anti-freezing solutions, dry & wet liners, Petrol Fuel and diesel fuel system maintenance, MPFI

maintenance, lubrication system services, Chassis lubrication, lubrication chart, maintenance and care of storage batteries, battery testing methods, maintenance of ignition systems, tyre service & reconditioning. **10 Hours**

Unit 4

Air Pollution due to Automobile Exhaust: Sources of Emission, Exhaust gas constituents & analysis, Ingredients responsible for air pollution, Smoke, odour, Smog formation, Sources of pollution, effects, Analysis of air pollutants, Air pollution control models and equipment's. **10 Hours**

Unit 5

Exhaust Emission Control: Basic method of emission control, catalytic converter, after burners, reactor manifold, air injection, crank case emission control, evaporative loss control, Exhaust gas recirculation, Fuel additives. Pollution Norms: European pollution norms, Indian pollution norms as per Central Motor Vehicle Rules (C.M.V.R.). Characteristics of solid waste, Potential methods of solid waste disposal, Energy recovery from municipal and Industrial solid waste.

References:

1. **W. Steed,** "*Mechanics of Road Vehicles*," Illefe Books Ltd. London
2. **P M Heldt,** "*Automotive Chassis*," Chilton Co. NK
3. **Richard Stone**, "*Introduction to Internal Combustion Engines*," McMillan, London
4. **John B. Heyhood,** "*Internal Combustion Engines Fundamentals*," McGraw Hill
5. **H S Peavy, D R Rowe, G Tchobanoglous,** "*Environmental Engineering*," McGraw-Hill Book Company, New York.
6. **G Masters,** "*Introduction to Environmental Engineering and Science*," Prentice Hall International Editions

Subject Name & Code	Automotive Electrical and Electronic system – MAL243
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course outcome: At the end of the course, the student should be able to

1. Understand and explain fundamentals of automotive electrical and electronics systems
2. Apply the various concepts of electrical and electronics to small vehicle system.
3. Analyze the design considerations of various engine control systems in automotive electrical and electronics.
4. Engage in independent study as a member of a team and make an effective oral presentation on the usage of software tools/mini project.

Unit 1

Batteries: Principles and construction of lead-acid battery. Characteristics of battery, rating capacity and efficiency of batteries. Various tests on battery condition, charging methods. Starting System: Condition at starting. Behavior of starter during starting. Series motor and its characteristics. Principle and construction of starter motor. Working of different starter drive units.

10 Hours

Unit 2

Charging System: Generation of direct current. Shunt generator characteristics. Armature reaction. Third brush regulation. Cut-out. Voltage and current regulators. Compensated voltage regulator alternators principle & constructional aspects. **10 Hours**

Unit 3

Ignition, lighting Systems and accessories: Types, Construction and working of battery coil and magneto ignition systems. Relative merits, Centrifugal and vacuum advance mechanisms, types and construction of spark plugs, Lighting System and Accessories: Insulated and earth return systems. Positive and negative earth systems. Details of head light and side light. Headlight dazzling and preventive methods. Electrical fuel-pump, Speedometer, Fuel, oil and temperature gauges, Horn, Wiper systems. **12 Hours**

Unit 4

Automotive Electronics: Current trends in modern automobiles, Open and close loop systems-Components for electronic engine management. Sensors and Actuators: Basic sensor arrangement, Types of sensors: Oxygen sensors, Crank angle position sensors-Fuel metering/vehicle speed sensor and detonation sensor-Altitude sensor, flow sensor. Throttle position sensor.

10 Hours

Unit 5

Electronic Fuel Injection and Ignition Systems: Introduction, feedback carburetor systems. Advantages of electronic ignition systems, Digital Engine Control System: Open loop and closed loop control systems-Engine cranking and warm up control-Acceleration enrichment-Deceleration leaning and idle speed control. Distributor less ignition-Integrated engine control systems, Exhaust mission control engineering. Electronic dashboard instruments-Onboard diagnosis system, security and warning system. **10 Hours**

References

1. **Judge. A.W.,** "*Modern Electrical Equipment of Automobiles*," Chapman & Hall, London, 1992.
2. **Vinal. G.W.,** "*Storage Batteries*," John Wiley & Sons Inc., New York, 1985.
3. **William B. Ribbens,** "*Understanding Automotive Electronics*," 5th Edition, Butterworth, Heinemann Woburn, 1998.
4. "*Automotive Hand Book*," Robert Bosch, Bently Publishers, 1997, Reprint 2012.

OPEN ELECTIVE COURSES

LIST OF OPEN ELECTIVE COURSES

Students from any specialization have to register for ONE course in the even semester among these courses depending on which course is offered by the department

Course Code	Course Title	Credit pattern
ECPGOL1	IOT – Internet of Things	4:1:0
ECPGOL2	Solar Energy Systems	4:1:0
ECPGOL3	Machine learning	4:1:0
ECPGOL4	Six Sigma and manufacturing	4:1:0
ECPGOL5	Heuristics for optimization	4:1:0
ECPGOL6	Organizational Behavior and Financial Management	4:1:0
ECPGOL7	Deep learning	4:1:0
ECPGOL8	MEMS	4:1:0
ECPGOL9	Artificial Neural Networks	4:1:0

Subject Name & Code	**IOT - Internet of Things – ECPGOL1**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: After the completion of the course, student will be able to

1. Summarize on the term 'internet of things' in different Contexts.
2. Analyze various protocols for IoT.
3. Design a PoC of an IoT system using Raspberry Pi/Arduino
4. Apply data analytics and use cloud offerings related to IoT.
5. Analyze applications of IoT in real time scenario

Unit 1

FUNDAMENTALS OF IoT: Evolution of Internet of Things, Enabling Technologies, IoT Architectures, oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

10 Hours

Unit 2

IoT PROTOCOLS: IT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and Lora WAN, Zigbee, RFID and NFC. Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks (AODV & DSR), Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP, MQTT, AMQP and XMPP.

10 Hours

Unit 3

DESIGN AND DEVELOPMENT: Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino, Board details, IDE programming, Raspberry Pi, Interfaces and Raspberry Pi with Python Programming.

10 Hours

Unit 4

DATA ANALYTICS AND SUPPORTING SERVICES: Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine Learning – No SQL Databases, Hadoop Ecosystem, Apache Kafka, Apache Spark, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, Python Web Application Framework, Django, AWS for IoT, System Management with NETCONF-YANG.

10 Hours

Unit 5

CASE STUDIES/INDUSTRIAL APPLICATIONS: Cisco IoT system, IBM Watson

IoT platform, Manufacturing, Converged Plant wide Ethernet Model (CPwE), Power Utility Industry, Grid Blocks Reference Model, Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

12 Hours

References:

1. **David Hanes** *"IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things,"* Cisco Press, 2017.
2. **Arshdeep Bahga, Vijay Madisetti**," Internet *of Things – A hands-on approach*," Universities Press, 2015.
3. **David Boswarthick** "*The Internet of Things – Key applications and Protocols*," Wiley, 2012 (for Unit 2).
4. **Catherine Mulligan** "*From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence*," Elsevier, 2014.
5. **Dieter Uckelmann**, "Ar*chitecting the Internet of Things*," Springer, 2011.

Subject Name & Code	**Solar Energy Systems - ECPGOL2**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: After the completion of the course, student will be able to

1. Explain the technical and physical principles of solar cells and solar collectors,
2. Measure and evaluate different solar energy technologies through knowledge of the physical function of the devices,
3. Make critical comparisons of different solar energy systems,
4. Communicate technological, environmental and socio-economic issues around solar energy in a concise and an accessible way to a target group with basic technical skills.

Unit 1

ENERGY RESOURCES AND SOLAR SPECTRUM: World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance - Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the Earth, energy flux, solar constant for Earth, greenhouse effect.

10 Hours

Unit 2

SOLAR RADIATION AND MEASUREMENT: Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar isolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E).

10 Hours

Unit 3

SOLAR RADIATION GEOMETRY AND CALCULATIONS: Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence - Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram –. Shadow determination. Estimation of Sunshine hours at different places in India. Calculation

of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability.

10 Hours

Unit 4

SOLAR THERMAL ENERGY CONVERSION: Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles - Brayton cycle – Stirling cycle – Binary cycles – Combined cycles. Solar thermal power plants - Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electric power plant, central tower receiver power plant.

12 Hours

Unit 5

SOLAR ELECTRICAL ENERGY CONVERSION: Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.

10 Hours

References:

1. **Foster R., Ghassemi M., Cota A**., *"Solar Energy*," CRC Press, 2010.
2. **Duffie J.A., Beckman W.A**. "*Solar Engineering of Thermal Processes*," 3rd ed., Wiley, 2006.
3. **De Vos, A**., "*Thermodynamics of Solar Energy Conversion*," WileyVCH, 2008.
4. **Garg H.P., Prakash J**., "*Solar Energy Fundamentals and Applications*," Tata McGraw-Hill 2005.
5. **Kalogirou S**., "*Solar Energy Engineering*," Processes and Systems, Elsevier, 2009.
6. **Petela, R**., "*Engineering Thermodynamics of Thermal Radiation for Solar Power*," McGraw- Hill Co., 2010

Subject Name & Code	**Machine learning - ECPGOL3**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: At the end of course, student will be able to

1. Illustrate the algorithms for linear regression
2. Identify the algorithms for different classification
3. Analyze algorithms for unsupervised clustering algorithms
4. Evaluate various ANN, CNN and deep learning architectures
5. Apply regression and classification algorithms using modern computing tools.

Unit 1

Introduction to Machine Learning, Regression Problem and Classification Problem: Applications, Linear Regression: Single variable(feature), Linear Regression: Multivariable (multiple features) Normal Method, Gradient descent method, Bias Variance Trade off, Regularization (Ritz and Lasso) **10 Hours**

Unit 2

Linear Classification: Issues, Evaluation Measures: Confusion Matrix, Accuracy, Precision, Recall Features, Feature vectors, Principal Component Analysis, Discrimination, Fisher Discriminant Analysis (Two class, Multiclass), Logistic Regression, Neural network: Introduction to Rosenbalt Perceptron, Boolean functions using NN, Multi-Layer Perceptron, Back propagation algorithm, Gradient Descent, Stochastic Gradient Descent, Universal Approximation Theorem, NN model selection criteria. **12 Hours**

Unit 3

Bayesian Learning, Maximum Likelihood, Optimal classifier, Naïve Bayes Classifier, Hybrid Approach for Linearly non-separable data, Covers Theorem and related issues, Intro to Radial Basis function networks, Clustering: Connectivity based, Centroid based, Distribution based, density based, graph based. RLS Algorithm. **10 Hours**

Unit 4

Support vector Machine: Linearly separable pattern, Lagranges Optimization Technique (LOT), Applying LOT for SVM linearly separable case, Kernel functions, classifying linearly Not separable data using Kernel functions, Applying LOT for case of Linearly Not Separable data, Solving XOR problem using SVM kernel. **10 hours**

Unit 5

Introduction to Decision Tree Algorithm, Information Gain, Gini index, Ensemble Methods: Bagging, Boosting, Stacking, Random Forest Algorithm, Convolution Neural Network, Autoencoders, Deep Belief Networks (DBNs), Generative Adversarial Networks (GANs), Deep Learning Architectures LeNet 5, Alex Net, VGG 16, Inception, ResNet, ResNext, DenseNet. **10 hours**

References:

1. **T. Hastie, R. Tibshirani, J. Friedman**. "*The Elements of Statistical Learning*", 2e, 2009

2. **Christopher Bishop**, "*Pattern Recognition and Machine Learning*". 2e., 2010

3. **Simon Haykin**, "*Neural Networks and Learning Machines*", Pearson 3rd edition, 2008

Subject Name & Code	**Six Sigma Manufacturing - ECPGOL4**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Understand systematic method for achieving quality in product development and manufacturing with fundamentals of six sigma.
2. Design for six sigma towards product development.
3. Approach towards design for x by using algorithms.
4. Apply the tools and best practices for design development, optimization and verifying capability.
5. Revealing industry insider case studies.

Unit 1:

Quality concepts: What is quality? Quality assurance and product or service life cycle, development of quality methods. Six sigma fundamentals, what is six sigma? process, process mapping, process capability and six sigma, overview of six sigma process improvement and design for six sigma.

10 Hours

Unit 2:

Design for six sigma: What is six sigma theory? Why design for six sigma; phases of six sigma, difference between six sigma and design for six sigma (DFSS). Problems solved by DFSS, DFSS company and strategy. Design for six sigma project algorithms: Introduction, form of synergistic design team, determine customer expectations, understand functions required, evolution, generate concepts, select best concept, finalize the physical structure of selected concept, initiate design scoreboards and transfer function development, assess risk, transfer function optimization, design for x, prototyping design, validate design, launch mass production, project risk management.

10 Hours

Unit 3:

Design for x: Introduction, design for manufacturing and assembly (DFMA), design for reliability (DFR), Design for manufacturability, design for serviceability, design for environmentality, design for life cycle cost (LCC).

10 Hours

Unit 4:

Failure mode-effect analysis: Introduction, FMEA fundamentals, development of FMEA, process FMEA, quality system and control plans. Reliability prediction, introduction to descriptive and inferential statistics, measurement systems analysis, multi-vari studies, regression, Taguchi method for robust design, response surface methods, optimization methods, analytical and empirical tolerance design, reliability evaluation, statistical process control, linking design to operations.

12 Hours

Unit 5

Case studies on six sigma for technology and product development, Lean six sigma in services and manufacturing applications and case studies.

10 Hours

References:

1. **Kai Yang, Basem El-Haik,** *"Design for Six Sigma: A Road Map for Product Development,"* Tata McGraw Hill, 2003.
2. **C.M. Creveloing, J.L. Slutsky, D. Antis, Jr.,** *"Design for Six Sigma: In Technology and Product Development,"* Pearson Education 2003, Second impression 2008.
3. **Peter S. Pande, Robert P. Neuman, Roland R. Cavanagh,** *"The Six Sigma Way: How GE, Motorola, and Other Companies are Honing their Performance,"* Tata McGraw Hill, 2000.
4. **Sandra F. Furterer,** *"Lean Six Sigma in Services Applications and Case Studies,"* CRC Press, Taylor Francis Group 2009.
5. **Peter S. Pande, Robert P. Neuman, Roland R. Cavanagh, K**. *"The Six sigma Way: Team Field Book,"* Tata McGraw Hill, 2003.
6. **Joseph. A. De Fero, William Co Barnard,** *"Juran Institute's: Six Sigma Breakthrough and Beyond,"* Tata McGraw Hill, 2000

Subject Name & Code	Heuristics for Optimization - ECPGOL5
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Understand diverse heuristic algorithms for solving hard optimization problems
2. Apply various optimization techniques in practice to solve problems
3. Evaluate the problems by adopting the heuristic algorithm

Unit 1

Introduction to evolutionary computation: Biological and artificial evolution, Evolutionary computation and AI, different historical branches of EC.

10 Hours

Unit 2

Genetic Algorithms: Coding, Search operators, Selection schemes, Applications.

10 Hours

Unit 3

Simulated Annealing: Theoretical Approaches, Parallelization, Applications. Tabu Search: Neighborhood, Candidate list, Short term and Long term memory, Applications.

12 Hours

Unit 4

Ant Colony Algorithms: Overview, Basic algorithm, Variants, Formalization and properties of ant colony optimization, Applications.

10 Hours

Unit 5

Multi objective evolutionary optimization: Pareto optimality, Multiobjective evolutionary algorithms.

10 Hours

References:

1 . **Baeck T, Fogel D B & Michalewicz** "*Handbook on Evolutionary Computation*", IOP Press

2. **Michalewicz ,**'*Genetic Algorithms and Data Structures = Evolution Programms*", Springer.

3. **Goldberg D E**,"Genetic Algorithms in Search, Optimization & Machine Learning"- Addisson Wesley.

4. **Banzhaf W,Nordin P,Keller et al**."*Genetic Programming :An Introduction*" Morgan Kaufmann

5. **Fred Glover,** "*Tabu Search*,"

Subject Name & Code	Organizational Behavior and Financial Management - ECPGOL6
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Demonstrate the applicability of the concept of organizational behavior to understand the behavior of people in the organization.
2. Demonstrate the applicability of analyzing the complexities associated with management of individual behavior in the organization.
3. Analyze the complexities associated with management of the group behavior and financial in the organization

Unit 1

Introduction: Meaning-Definitions and scope of organizational behavior-people- Organizational structure-technology and environment-OB as a Behavioral science- Foundations of Individual Behavior: Biological Characteristics-Age-Sex-Marital Status-Number of Dependents-Tenure-Ability-Intellectual Abilities- Physical Abilities-The Ability-Job fit personality-personality determinants-Personality Traits-Major Personality Attributes influencing OB-Matching personality and Jobs-learning –Theories of learning shaping-Values, attitudes, and Job satisfaction: Importance of Values-Sources of Value system-Sources and types of Attitudes.

12 Hours

Unit 2

Motivation: The concept of Motivation-Early Theories of Motivation-Hierarchy of Needs theory-theory X and Theory Y-Hygiene theory-contemporary theories of motivation-ERG Theory-three needs theory-cognitive evaluation theory.

10 Hours

Unit-3

Foundation of group behavior: Defining and classifying groups-group process-group tasks-cohesive groups-group dynamics-leadership-nature and importance-functions-styles-communications-nature and types-effective communication-Roles of Formal and informal

communication-Conflict management-The process of conflict-types of conflict-functional and dysfunctional conflict-resolution of conflict.

10 Hours

Unit-4

Financial management- Meaning, Scope, and functions – Financial Planning – Financial analysis- Financial Control - Objectives-Profit Maximization and Wealth Maximization, their social implications. Sources of capital, types of capital.

10 Hours

Unit-5

Working Capital Management & capital structure decision: Meaning concept determinants of working capital, Determination of optimal investment in working capital, Capital structure theories-NI, NOI, traditional and M-M theories; EBIT -EPS Analysis

10 Hours

References:

1. **Robbins, S. P., & Judge, T**. "*Organizational behavior*" 15th ed. Boston: Pearson, 2013.
2. **Newstrom J. W., & Davis, K.** "*Human behavior at work*"12th ed. Tata McGraw Hill, 2011.
3. **Nelson, D , Quick, J.C., & Khandelwal, P**., "*ORGB*," , Cengage Learning,2011.

Subject Name & Code	**Deep Learning - ECPGOL7**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course outcomes: At the end of this course the student will be able to

1. Solve problems in linear algebra, probability, optimization, and machine learning.
2. Design convolution networks for handwriting and object classification from images or video.
3. Evaluate the performance of different deep learning models (e.g., with respect to the bias-variance trade-off, overfitting and underfitting, estimation of test error).

Unit 1

Deep Networks Regularization & optimization: Feed forward networks- Gradient based learning, hidden units, backpropagation. Regularization –parameter norm, Dataset augmentation, Noise robustness, semi-supervised learning, multitask learning, early stopping, sparse representation, bagging, ensemble, dropout, manifold learning. Optimization for training deep models- challenges in neural network optimization, adaptive learning rates, and optimization strategies.

10 Hours

Unit 2

Convolution networks: Convolution network, pooling, structured output, data types, efficient convolution algorithm, randomized and unsupervised features, Recurrent and recursive networks- unfold computation graphs, recurrent neural networks, encoder-decoder, deep recurrent network, recursive neural network, echo state network, optimization, and challenges. Practical methodology and its application- performance metrics, selecting hyper parameters. Some application of deep learning like computer vision, speech recognition.

10 Hours

Unit 3

Linear factor models: Probabilistic PCA and factor analysis, independent component analysis, slow feature analysis, sparse coding, and manifold interpretation of PCA. Auto encoders- auto encoders, regularized auto encoders, stochastic auto encoder- decoder, learning manifold with auto encoder, predictive sparse decomposition.

10 hours

Unit 4

Representation learning: Greedy unsupervised pre-training, transfer learning, distribution representation, exponential gain, providing clues for underlying causes. Structured probabilistic model for deep learning – challenges of unstructured modeling, using graph to describe unstructured model, sampling from graphical models, learning about dependencies, deep learning approach towards structured probabilistic model. Monte carlo methods- sampling monte- carlo methods, importance sampling, markov chain montecarlo methods, gibbs sampling.

12 Hours

Unit 5

Deep generative models: Boltzmann machine, restricted Boltzmann machine, deep belief networks, Boltzmann machine for real valued data, convolutional Boltzmann machine, other Boltzmann machine, back propogation through random operations, directed generative methods, generative stochastic methods, evaluating generative methods.

10 Hours

References:

1. **Ian Goodfellow and YoshuaBengio and Aaron Courville**, "*Deep Learning*," MIT press, Cambridge, Massachusetts, London, ,2016.
2. **Nikhil Buduma, Nicholas Locascio**, "*Fundamentals of Deep Learning*," O'Reilly media, 2017.
3. **Li Deng & Dong Yu**, "*Deep Learning: Methods and Applications*," 2014.
4. **Andrew W, "***Deep Learning*," 2016

Subject Name & Code	**MEMS - ECPGOL8**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course outcomes: At the end of this course the student will be able to

1. Explain fundamentals of sensors/actuators, polymers and device fabrication techniques.
2. Analyze the design considerations of sensors and actuators.
3. Apply MEMS to disciplines beyond electrical and mechanical engineering.
4. Engage in independent study as a member of a team and make an effective oral presentation on the usage of software tools/mini project.

Unit 1

INTRODUCTION: Intrinsic Characteristics of MEMS, Energy Domains and Transducers-Sensors and Actuators, Introduction to Microfabrication, Silicon based MEMS processes, New Materials – Review of Electrical and Mechanical concepts in MEMS, Semiconductor devices, Stress and strain analysis, Flexural beam bending- Torsional deflection.

10 Hours

Unit 2

SENSORS AND ACTUATORS-I: Electrostatic sensors, Parallel plate capacitors, Applications – Interdigitated Finger capacitor, Comb drive devices, Thermal Sensing and Actuation, Thermal expansion, Thermal couples, Thermal resistors Applications, Magnetic Actuators, Micromagnetic components, Case studies of MEMS in magnetic actuators. **10 Hours**

Unit 3

SENSORS AND ACTUATORS-II: Piezoresistive sensors, Piezoresistive sensor materials - Stress analysis of mechanical elements. Applications to Inertia, Pressure, Tactile and Flow sensors, Piezoelectric sensors and actuators, piezoelectric effects – piezoelectric materials, Applications to Inertia, Acoustic, Tactile and Flow sensors. **10 Hours**

Unit 4

MICROMACHINING: Silicon Anisotropic Etching, Anisotrophic Wet Etching, Dry Etching of Silicon, Plasma Etching, Deep Reaction Ion Etching (DRIE), Isotropic Wet Etching, Gas Phase Etchants, Case studies Basic surface micromachining processes, Structural and Sacrificial Materials, Acceleration of sacrificial Etch, Striction and Antistriction methods, Assembly of 3D MEMS, Foundry process. **12 Hours**

Unit 5

POLYMER AND OPTICAL MEMS: Polymers in MEMS, Polimide - SU-8 - Liquid Crystal Polymer (LCP), PDMS, PMMA, Parylene Fluorocarbon, Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS, Lenses and Mirrors, Actuators for Active Optical MEMS. **10 Hours**

References:

1. **Chang Liu**, '*Foundations of MEMS'*, Pearson Education Inc., 2006.
2. **Nadim Maluf**, "An *introduction to Micro electro mechanical system design*", Artech House, 2000.
3. **Mohamed Gad-el-Hak**, "The *MEMS Handbook*", CRC press Baco Raton, 2000
4. **Tai Ran Hsu**, "*MEMS & Micro systems Design and Manufacture*" Tata McGraw Hill, New Delhi, 2002.
5. **Julian w. Gardner, Vijay k. varadan, Osama O.Awadelkarim**, "*Micro sensors mems and smart devices*", John Wiley & son LTD,2002
6. **James J.Allen**, "*Micro Electro Mechanical System Design*", CRC Press published in 2005

Subject Name & Code	**Artificial Neural Networks - ECPGOL9**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course outcomes: At the end of this course the student will be able to

1. Analyze ANN learning, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning and Boltzmann learning.
2. Implement Simple perception, Perception learning algorithm, Modified Perception learning algorithm.
3. Analyze the limitation of Single layer Perceptron and Develop MLP with hidden layers

Unit 1

Background to ANN: Introduction to artificial neural networks (ANN), intelligence, learning and knowledge. Historical development of Artificial Intelligence (AI) leading to ANN. PDP models -- Interactive and competition (IAC) and Constraint Satisfaction (CS) models.

10 Hours

Unit 2

Basics of ANN: Basics of ANN, terminology, models of neurons, topology, basic learning laws, activation and synaptic dynamics models.

10 Hours

Unit 3

Analysis of Feedforward Neural Networks (FFNN): Overview, linear associative networks, perceptron network, multilayer perceptron, gradient descent methods, backpropagation learning.

10 Hours

Unit 4

Analysis of Feedback Neural Networks (FBNN): Overview, Hopfield model, capacity, energy analysis, state transition diagrams, stochastic networks, Boltzmann-Gibbs Law, simulated annealing, Boltzmann machine. **12 Hours**

Unit 5

Applications of ANN: Travelling salesman problem, image smoothing, speech recognition and texture classification.

10 Hours

References:

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